# Impact of climate change on vegetable production

Mahendra Kr. Yadav[1*], Juri Das[2], Satyendra Kumar[3]

**Yadav MK, Das J, Kumar S. Impact of climate change on vegetable production. AGBIR.2025;41(2):1-4.**

Vegetables are an important component of human diet as they are the only source of nutrients, vitamins and minerals. They are also good remunerative to the farmer as they fetch higher price in the market. Likewise other crops, they are also being hit by the consequences of climate change such as global warming, changes in seasonal and monsoon pattern and biotic and abiotic factors. 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. It can also be referred as any change in climate over time, whether due to natural variability or as a result of human activity. Under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pest and disease problems are common and they render the vegetable cultivation unprofitable. As many physiological processes and enzymatic activities are temperature dependent, they are going to be largely affected. Drought and salinity are the two important consequences of increase in temperature worsening vegetable cultivation. Increase in $CO_2$ may increase crop yields due to increased $CO_2$ fertilization, but decreases after some extent. Anthropogenic air pollutants such as $CO_2$, $CH_4$ and CFC are contributing to the global warming and dioxides of nitrogen and sulphur are causing depletion of ozone layer and permitting the entry of harmful UV rays. These effects of climate change also influence the pest and disease occurrences, host-pathogen interactions, distribution and ecology of insects, time of appearance, migration to new places and their overwintering capacity, there by becoming major setback to vegetable cultivation. Among the all vegetables, is most vulnerable to climate change due to its exact climatic requirement for various physiological processes.

**Key Words:** *Climate change; Drought; Salinity; Flooding; Vegetable production*

## INTRODUCTION

Vegetables are the only food source for vitamins, minerals, and other nutrients, they play a significant role in a human diet. They are also good remunerative to the farmer as they fetch higher price in the market. Likewise other crops, they are also being hit by the consequences of climate change such as global warming, changes in seasonal and monsoon pattern and biotic and abiotic factors. Under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pest and disease problems are common and they render the vegetable cultivation unprofitable. Since many physiological functions and enzymatic activity depend on temperature, they will be significantly impacted. Even in high-yield, high-tech agricultural areas, one of the most important elements affecting crop productivity from year to year is climate unpredictability. Climate change encompasses various factors such as temperature rise, altered rainfall patterns, rising sea levels, saline water intrusion, and the occurrence of floods and droughts. It is acknowledged as a worldwide concern. At present due to anthropogenic activities like industrialization, deforestation and automobiles etc. changes in the climate are being taken place, which will again turn detrimental to life. The primary driver of rising ocean currents, acidification, forest fires, and accelerated ozone depletion is the earth's temperature, which has been rising annually [1].

One of the most important issues of the twenty-first century is climate change, which has numerous effects on both the environment and human existence. Agriculture is one of the areas most affected by climate change, and it is a crucial sector for the global economy and food security. Vegetable crops, which play a crucial role in the global food system, can be deeply affected by climate fluctuations. Raising temperatures are expected to reduce the amount of crops that are desired while encouraging the growth of pests and weeds. Alterations in rainfall cycles will increase the probability of short-term crop losses and long-term yield damage. Additionally, individuals may relocate in order to adjust to weather-related risks, particularly those that influence agriculture, which means that climate change may have an impact on migratory patterns. Subsistence or smallholder farmers in developing countries are among the groups most affected by climate change. The vulnerability of these regions to climate change arises due to their predominantly tropical location, coupled with multiple socio-economic, demographic and political constraints that hinder their capacity to adapt to these changes agriculture is a fundamental aspect of our society, providing food and resources for a growing population. However, climate change is putting this sector at risk through rising temperatures, changing rainfall patterns and an increase in the frequency and intensity of extreme weather events. Our study highlights the need to address climate change in a differentiated way, taking into account the specificities of each agricultural sector, and therefore aims not only to organize and summaries current research but also to fill an important gap in the existing literature by focusing on the impact of climate change on vegetable crops.

Particularly for those who primarily grow vegetables, small and marginal farmers may be more affected by climate change. Vegetables is considered as protective foods because of ability to prevent diseases by supplying vitamins and minerals and moreover its nutritional quality is determined by soil factors, temperature, light and $CO_2$ so, a little change in these parameter will bring a drastic change in the quality there by the nutritional value of the vegetables may be reduced or increased for example increase in the level of $CO_2$ improved the vitamin C, sugars, acids and carotenoids in tomatoes. High-temperature stress has been reported to decrease vitamin C, starch, sugars and many antioxidants especially anthocyanin's and volatile flavour compounds in fruits. Climate variations have also been documented to impact the quality of vegetables after harvest, result in significant losses, and compromise food safety while being stored, for instance by altering the populations of fungus that produce aflatoxin [2-5].

Vegetables are health-promoting foods that are packed with vitamins, micronutrients, and medicinal and nutraceutical ingredients that are essential for the treatment of many illnesses. Additionally, the production of vegetables creates jobs that secure a living. However, a variety of agro-climatic conditions have a considerable impact on the intricate process of growth and development. As a result, any environmental aberration brought on by climate change may subject this group of plants to previously unheard-

[1]*Department of Agriculture, RNB Global University, Bikaner, India*

[2]*Department of Agriculture, Teerthanker Mahaveer University, Moradabad, India*

[3]*Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, India*

***Correspondence:*** *Mahendra Kr. Yadav, Department of Agriculture, RNB Global University, Bikaner, India; E-mail: yadavmp2040@gmail.com*

***Received:*** *21-Dec-2023, Manuscript No. AGBIR-23-123212;* ***Editor assigned:*** *23-Dec-2023, PreQC No. AGBIR-23-123212 (PQ);* ***Reviewed:*** *06-Jan-2024, QC No. AGBIR-23-123212;* ***Revised:*** *11-Feb-2025, Manuscript No. AGBIR-23-123212 (R);* ***Published:*** *18-Feb-2025, DOI: 10.37532/0970-1907.25.41(2).1-4*

of stressors, which could result in the crop failing completely in a grower's field. The primary factors that impede maximum productivity, aside from quality and consumer acceptance, are typically extreme temperatures, restricted soil moisture, decreased irrigation water availability, recurrent flooding, elevated acidity or salinity, soil erosion, high wind speeds, an increase in the frequency of hailstorms and thunderstorms, frost damage, tsunamis, etc. Sudden change in climate also influences the status of soil fertility, occurrence of pests and diseases, host-pathogen interactions, soil microbial population and behaviour of the pollinators. Reduced production and productivity due to the development of genetically weakened seeds is the ultimate outcome of climate change which may invite a crisis in food reserve in the future. All of these have a substantial impact on the global system of vegetable cultivation, which in turn affects the economic yield—which, from the perspective of the grower, is crucial. Therefore, in order to mitigate its negative effects in a timely manner, it is imperative to get an awareness of the implications and ramifications of climate change on the production of vegetables [6].

## LITERATURE REVIEW

### Temperature effect on vegetable production

Studies show that changes in temperature, including increases in mean temperatures and the frequency of heat waves, can significantly affect the growth and development of vegetable crops. Extreme temperatures can lead to heat stress, affecting yields and quality. Every vegetable requires a certain temperature for healthy growth and development, however the ideal temperature varies depending on the crop. In addition, temperature affects many crops' growth range and yield. The crop will be subjected to more temperature stress due to climate change. Different solanaceous crops may be impacted by the high temperatures in different ways. The potato production will be negatively impacted by climate change, among other vegetable crops. Potatoes are sensitive to temperature changes because they need specific temperatures and lengths of days for tuber growth and flowering. Previous research has examined how India's potato output is impacted by climate change by Singh, et al. [7]. Luck, et al. predicted 16% decrease in West Bengal's potato tuber output by 2050 if no specific measures are taken [8]. The yield of potato tubers is sharply reduced at temperatures above 21°C, and tuber formation is completely inhibited at 30°C. Temperature, either by itself or in combination with other environmental conditions, significantly affects tomatoes. High temperatures in tomatoes affect the plants' ability to photosynthesize and result in abnormalities in the endothesium and epidermis, as well as poor pollen formation and absence of stromium opening. Stress related to temperature before anthesis is linked to poor pollination, lack of strontium opening, abnormalities in the anther, especially with regard to the epidermis and endothesium, and development. Tomatoes do not reproduce well under high temperatures due to improper pollen production, abnormal growth of the female reproductive tissues, hormonal imbalances, reduced levels of carbohydrates, and lack of pollination. Potato tubers with high starch content are favored by the processing industry. At low temperatures starch is converted into the sugar, which causes browning due to charring of sugar while chips making there by reduces their preference by the processing industry. In the end, this leads to higher postharvest losses than the current average, which is estimated to be between 40% and 50%. This issue is most prevalent in places where wintertime low temperatures occur at night.

All plants are susceptible to low temperatures, such as freezing and chilling harm, though the mechanisms and kinds of damage differ greatly. A plant will suffer chilling injury if it is exposed to temperatures above 0°C (0-10°C), and freeze injury if it is somewhat exposed to temperatures below 0°C. Since ice crystals are created from cytoplasmic water, freeze damage results in cell wall rupture and the death of cytoplasmic components in all plants. While most crops that grow in cooler climates often survive with little freezing if the freezing condition is not too severe, crop plants that develop in tropical climes may suffer substantial freezing injury, even occurrence of tiny freezing circumstances. Despite its origins in a temperate region, lettuce is unique in this sense because it cannot survive at temperatures below 0°C. Exposure to chilling temperature in temperate climate may lead to a severe reduction of yield or complete crop failure due to either direct damage or delayed maturation. For plants that are susceptible to chilling, even a slight decrease in temperature might result in a 50% decrease in their yield. It has been observed that low temperatures (down to 8-12°C) affect tomato fruit set percentage, pollen tube growth speed, and seed germination. Growth reduction of muskmelon (reticulates group) and watermelon. Bean seeds, in particular, are particularly susceptible to low temperatures during imbibition and may not germinate in such conditions [9].

### Drought effect on vegetable production

A prolonged period of unusually low rainfall, especially one that negatively impacts growing or living conditions, is referred to as a drought. The single biggest factor affecting global food security and the cause of the great famines of history is unpredictable drought. Since vegetables are by nature succulent goods, they typically contain more than 90% water. Water, therefore, has a major impact on the quantity and quality of vegetables; drought circumstances significantly lower vegetable productivity. An increase in solute concentration in the surrounding environment (soil) brought on by drought stress results in an osmotic flow of water out of plant cells. This leads to an increase of the solute concentration in plant cells, thereby lowering the water potential and disrupting membranes and cell processes such as photosynthesis. The timing, intensity, and duration of drought spells determine the magnitude of the effect of drought found that water stress causes considerable reductions in leaf relative water content, chlorophyll content, electrolyte leakage, and vegetative growth. High water stress plants also produce fewer and lower-quality fruits. Water stress causes considerable reductions in leaf relative water content, chlorophyll content, electrolyte leakage, and vegetative growth. High water stress plants also produce fewer and lower-quality fruits. Potato is highly sensitive to drought; a moderate level of water stress can also cause reductions in tuber yield. Tomatoes are very sensitive to water deficits during immediately after transplanting, at flowering and fruit development. Climate change is predicted to have a significant impact on water availability, and extreme water stress will reduce crop yield, especially for vegetables. Drought is a serious issue in arid and semi-arid countries. It is the main cause of agricultural loss globally, with most crop plants experiencing average yield reductions of over 50%. Insufficient rainfall or low soil moisture levels can produce drought stress in plants, which can lead to a range of physiological, genetic, and biochemical reactions that severely limit crop growth. The occurrence of drought circumstances has a negative impact on potato tuber sprouting and the germination of seeds in vegetable crops such as onion and okra. Tomatoes experience floral abscission due to dryness. Water stress during the reproductive stage of tomatoes has been linked to a reported yield drop of more than 50%. Water stress during the flowering stage has been proposed to decrease photosynthesis and the quantity of assimilates given to floral organs, potentially increasing the rate of abscission. An increase in solute concentration in the surrounding environment (soil) brought on by drought stress results in the osmotic movement of water out of plant cells. This leads to an increased water loss in plant cells and inhibition of several physiological and biochemical processes such as photosynthesis, respiration etc. thereby reduces productivity of most vegetables. Apart from lowering stomatal conductance to suppress the photosynthetic rate, drought stress also induces metabolic impairment. In low water conditions, photosynthetic capability and photosynthesis are decreased. Additionally, a decrease in the activity of the enzymes Sucrose Phosphate Synthase (SPS) and invertase, which influence the availability and use of sucrose, suggests that the water stress also had an impact on the biochemical capacity. The SPS is thought to be essential for sucrose resynthesis and for maintaining the flux of assimilating carbon from source to growing sink. The lowered activity of invertase may have an impact on the utilization of sucrose, leading to a decrease in ovarian development and a reduction in the concentration of hexoses [10].

### Salinity effect on vegetable production

Salinity is a serious problem that reduces growth and productivity of vegetable crops in many salt-affected areas. Vegetable production is threatened by increasing soil salinity particularly in irrigated croplands which supply 40% demand of the food in the world. In hot and dry environments, high evapotranspiration results in substantial water loss from soil, thus leaving salt around the plant roots which interferes with the plant's ability to uptake water. Physiologically, salinity imposes an initial water deficit that results from the relatively high solute concentrations in the soil, causes ion-specific stresses resulting from altered $K^+/Na^+$ ratios, and leads to a buildup in $Na^+$ and $Cl^-$ concentrations that are detrimental to plants [11].

While cucumber, eggplant, pepper, and tomato are only slightly sensitive to saline soils, onions are susceptible to them. In cabbage, salinity significantly reduces the percentage and pace of germination as well as the length and weight of the fresh roots and shoots. When heat and salinity are coupled, the young, expanding potato leaves' ability to prevent salt buildup is damaged, which lowers the leaf area index and canopy functioning and prevents vegetative growth recovery. According to Lopez, et al. in chilies, salinity lowers the amount of dry matter produced, leaf area, relative growth rate, and net absorption rate [12]. The author also mentioned that salinity has a greater effect on a plant's fruit yield than it does on the weight of each individual fruit. All cucurbits lose weight, both fresh and dry, when exposed to high salt concentrations. Both the total chlorophyll content and the relative water content have decreased as a result of these modifications. In bean plants, salt stress results in modifications to stomata conductance, quantity, and size as well as reduction of growth and photosynthetic activity. In bean plants affected by salinity, it lowers transpiration and the cell water potential [13].

## Flooding effect on vegetable production

Most of the vegetables are highly sensitive to flooding, especially those who are shallow rooted. Under waterlogged conditions, the roots strive for oxygen as soil air is replaced by inundating water. As a result, asphyxia severely impairs roots' ability to breathe and continue absorbing water and nutrients as usual. As a result, the root becomes necrotic, making soil-borne viruses more likely to infect it. Tomato plants that have been flooded have been shown to accumulate endogenous ethylene, which damages the plants. Low oxygen levels stimulate an increased production of an ethylene precursor, 1-minocyclopropane-1-carboxylic acid (ACC), in the roots. The rapid development of epinastic growth of leaves is a characteristic response of tomatoes to water-logged conditions and the role of ethylene accumulation has been implicated. Further reports indicated that an internal ethanol concentration of 60 m.mol/L appeared to be the threshold value for the survival of pea seedlings, and that anoxic death occurred when this concentration was exceeded. Rising temperatures exacerbate the symptoms of flooding; tomato plants typically die and wilt quickly after a brief period of flooding at high temperatures. The occurrence of flooding conditions normally cause Oxygen ($O_2$) deficiency which arises from a slow diffusion of gases in water and $O_2$ consumption by microorganisms and plant roots. The majority of plants, especially tomatoes, are extremely susceptible to floods, and there is little genetic diversity in this trait. Vegetables damaged by flooding are typically caused by a decrease in oxygen in the root zone, which impedes aerobic processes. Tomato plants that have been flooded build up endogenous ethylene, which harms the plants. The rapid development of epinastic growth of leaves is a characteristic response of tomatoes to waterlogged conditions and the role of ethylene accumulation has been implicated. Rising temperatures cause the symptoms of flooding to worsen; tomato plants typically die and wilt quickly after a brief period of flooding at high temperatures. Onion is also sensitive to flooding during bulb development with yield loss up to 30-40%. These stresses are the primary cause of yield losses worldwide by more than 50% plant and the response of plants to environmental stresses depends on the developmental stage and the length and severity of the stresses. In addition, excessive rainfall poses a hazard to vegetable output. Flooding inhibits aerobic processes by lowering the oxygen content in the root zone. Tomato plants that are flooded accumulate endogenous ethylene, which harms the plants. Flooding and high temperatures lead plants to wilt and die quickly. Droughts and heat waves can predispose plants to infection, storms can accelerate spore distribution by wind, and floods can facilitate the spread of water-borne infections [14].

## Impact on pests and diseases effect in vegetable production

Climate change can influence the prevalence and distribution of pests and diseases. Warmer temperatures and changes in humidity can create more favorable conditions for some pests, potentially leading to increased pest pressure and the spread of certain diseases. Raising the temperature causes an early conclusion of the life cycle and increased fecundity in certain insects with short life cycles, like diamond back moths and aphids. As a result, these are able to generate more offspring year than they would normally. On the other hand, certain insects' life cycles can take several years to finish. Because soil acts as an insulating material that tends to cushion temperature variations more than air does, some insect species that live in soil for all or part of their life cycle likely to suffer more than insects found above the soil's surface. Insect species migrate northward in response to temperature increases, although in the tropics, elevated temperatures may have unfavorable effects on particular pest species. Elevated air temperature raises the rates of insect development and oviposition, epidemics, and importation of invasive species; nevertheless, it lowers the efficacy of fungal biocontrol of insects, the dependability of economic threshold levels, the diversity of insects in ecosystems, and parasitism. In general, insects develop more quickly and reproduce more frequently in response to rising temperatures. Higher temperatures will hasten the growth of Colorado potato beetles, European corn borer, onion maggots, and cabbage maggots. The breeding season will last longer and the rate of reproduction will rise with rising temperatures. Research on moths and aphids has demonstrated that rising temperatures can enable insects to attain their lowest flying temperature earlier, contributing to enhanced dispersal capacities. Higher temperatures cause faster depletion of stored nutritional resources, which shortens the length of insect diapauses. Warming in winter may cause delay in onset and early summer may lead to faster termination of diapauses in insects, which can then resume their active growth and development. This has a significant implication: Under a global warming scenario, an increase in temperature between 1°C and 5°C will improve insect survivability due to low winter mortality, higher population build-up, early infestations, and subsequent crop loss by insect pests. Potato, of all vegetables, is most vulnerable to climate change due to its exact climatic requirement for various physiological processes. These effects of climate change also influence the occurrence of pests and diseases, host-pathogen interactions, distribution and ecology of insects, time of appearance, migration to new places, and their capacity to overwinter. As a result, they pose a serious threat to the cultivation of vegetables [15].

# DISCUSSION

## Carbon dioxide levels and nutritional changes

Elevated carbon dioxide levels, a result of climate change, can impact the nutritional content of vegetables. While increased $CO_2$ levels may stimulate initial growth, they might lead to reductions in certain nutrients, affecting the overall nutritional quality of crops. Increase in $CO_2$ may increase crop yields due to increased $CO_2$ fertilization, but decreases after some extent. Anthropogenic air pollutants such as $CO_2$, $CH_4$ and CFC's are contributing to the global warming and dioxides of nitrogen and sulphur are causing depletion of ozone layer and permitting the entry of harmful UV rays. Due to increased anthropogenic activities, concentration of green-house gases like $CO_2$ and $CH_4$ is increasing in the atmosphere day by day. They have a direct impact on plant growth and development in addition to being the source of global warming. Plant growth and development are directly impacted by rising $CO_2$ levels in the environment. Up to a certain point, potato plants cultivated in high $CO_2$ environments may have higher photosynthetic rates; but, as $CO_2$ concentration rises, these rates will eventually decrease. Because the expression of genes linked to ripening is suppressed by high ambient $CO_2$, tomato fruit cannot mature. This is likely because high $CO_2$ causes stress. Studies have demonstrated that plants growing in high $CO_2$ concentrations produce leaves and stems at faster rates. This could lead to denser canopies with increased humidity, which is conducive to disease growth. The crop residue that disease organisms can overwinter on due to lower plant breakdown rates in high $CO_2$

environments may result in larger amounts of inoculum at the start of the growing season and earlier and more rapid disease epidemics. Pathogen growth can be affected by higher $CO_2$ concentrations resulting in greater fungal spore production. However, increased $CO_2$ can result in physiological changes to the host plant that can increase host resistance to pathogens [16-20].

## CONCLUSION

On the basis of above finding under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pest and disease problems are common in vegetable cultivation. In addition to exacerbating the environmental stress on vegetable crops, climate change has a negative effect on productivity and quality. Environmental stressors such as rising temperatures, decreased availability of irrigation water, flooding, and salinity are considered to be the main factors impeding the growth of vegetable yield. As many physiological processes and enzymatic activities are temperature dependent, they are going to be largely affected. Drought and salinity are the two important consequences of increase in temperature worsening vegetable cultivation. Increase in $CO_2$ may increase crop yields due to increased $CO_2$ fertilization, but decreases after some extent. Anthropogenic air pollutants such as $CO_2$, $CH_4$ and CFC are contributing to the global warming and dioxides of nitrogen and sulphur are causing depletion of ozone layer and permitting the entry of harmful UV rays. These effects of climate change also influence the pest and disease occurrences, host-pathogen interactions, distribution and ecology of insects, time of appearance, migration to new places and their overwintering capacity, there by becoming major setback to vegetable cultivation.

## REFERENCES


1. Ayyogari K, Sidhya P, Pandit MK. Impact of climate change on vegetable cultivation-A review. Int J Agri Environ Biotechnol. 2014;7(1):145-155.
2. Kang Y, Khan S, Ma X. Climate change impacts on crop yield, crop water productivity and food security–A review. Prog Nat Sci. 2009;19(12):1665-1674.
3. Bates B, Kundzewicz Z, Wu S. Climate change and water. Intergovernmental Panel on Climate Change, Technical Paper VI, Geneva, Switzerland. 2008:210.
4. Rakshit A, Sarkar NC, Pathak H, et al. Agriculture: A potential source of greenhouse gases and their mitigation strategies. IOP Conf Ser: Earth Environ Sci. 2009;6(24):242033.
5. Singh VK. Climate change and its impact on agriculture: A review. Int J Agri Environ Biotechnol. 2012;5(3):297-302.
6. Dumitru EA, Berevoianu RL, Tudor VC, et al. Climate Change impacts on Vegetable crops: A systematic review. Agric. 2023;13(10):1891.
7. Singh JP, Lal SS, Pandey SK. Effect of climate change on potato production in India. Central Potato Research Institute, Shimla, Newsletter. 2009;40:17-18.
8. Luck J, Asaduzzaman M, Banerjee S, et al. Project report of Asia pacific network for global change research. 2010.
9. Cotty PJ, Jaime-Garcia R. Influences of climate on aflatoxin producing fungi and aflatoxin contamination. Int J Food Microbiol. 2007;119(1-2):109-115.
10. Prasad BV, Chakravorty S. Effects of climate change on vegetable cultivation-A review. Nat Environ Pollut Technol. 2015;14(4):923-929.
11. Abdalla AA, Verkerk K. Growth, flowering and fruit-set of the tomato at high temperature. Neth J Agri Sci. 1968;16(1):71-76.
12. Sato S, Peet MM, Thomas JF. Determining critical pre-and post-anthesis periods and physiological processes in *Lycopersicon esculentum* Mill. exposed to moderately elevated temperatures. J Exp Bot. 2002;53(371):1187-1195.
13. López MA, Ulery AL, Samani Z, et al. Response of chile pepper (*Capsicum annuum* L.) to salt stress and organic and inorganic nitrogen sources: I. Growth and yield. Trop Subtrop Agroecosystems. 2011;14(1):137-147.
14. Peet MM, Willits DH, Gardner R. Response of ovule development and post-pollen production processes in male-sterile tomatoes to chronic, sub-acute high temperature stress. J Exp Bot. 1997;48(1):101-111.
15. Pardossi A, Vernieri P, Tognoni F. Involvement of abscisic acid in regulating water status in *Phaseolus vulgaris* L. during chilling. Plant Physiol. 1992;100(3):1243-1250.
16. la Pena RD, Hughes J. Improving vegetable productivity in a variable and changing climate. J SAT Agric Res. 2007;4(1):1-22.
17. Kirnak H, Kaya C, Tas I, et al. The influence of water deficit on vegetative growth, physiology, fruit yield and quality in eggplants. Bulg J Plant Physiol. 2001;27(3-4):34-46.
18. Jefferies RA, Mackerron DK. Responses of potato genotypes to drought. II. Leaf area index, growth and yield. Ann Appl Biol. 1993;122(1):105-112.
19. Sivakumar R, Nandhitha GK, Boominathan P. Impact of drought on growth characters and yield of contrasting tomato genotypes. Madras Agric J. 2016;103:78-82.
20. Bhatt RM, Srinivasa Rao NK, Upreti KK, et al. Hormonal activity in tomato flowers in relation to their abscission under water stress. Indian J Hortic. 2009;66(4):492-495.