Technologies for Horticultural Crops for Adaptation to Climate Change

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Abstract

Climate change has high impact on the horticultural crops. Variability of temperature and precipitation hinder vegetative growth of horticultural crops. This paper id focused on the technological options for climate resilient horticultural production. It also describes how through selecting appropriate technique during cultivation can avoid production loss due to climate induced factors.

1. Introduction

In the twenty first century, climate change is potential threat to human civilization. The Intergovernmental Panel on Climate Change (IPCC) has projected a temperature increase of 0.5 to 1.2 °C by 2020, 0.88 to 3.16 °C by 2050 and 1.56 to 5.44 °C by 2080, depending on the scenario of future development in the Indian region. Apart from increase in temperature, climate change is projected to cause variations in rainfall, increase the frequency of extreme events such as heat, cold waves, frost days, droughts, floods, etc. As a result, it adversely affects food production. Horticultural crops are most vulnerable to this condition. Since horticultural crops are major pillar of nutritional security, prevention of crop failure in horticultural sector is important aspect.

2. Possible impact of climate change in horticultural crops

Horticultural crops play an important role in ecologically sensitive hilly, coastal, rain fed and dry land area. Climate change has some impact on horticultural crops due to erratic rainfall, general warming and enhanced biotic and abiotic stresses. Various plant processes like vegetative growth, flowering, fruiting and fruit quality are highly vulnerable to climate changes. High temperature in flowering times impairs pollinator movement, dries up pollen and stigma. As a result, poor fruiting will takes place. Similarly in case of fruit crops, fruits will develop more rapidly and mature earlier. High temperature impaired flower bud differentiation and reduced fruit set. In mango, frequent rains occurring during May-June also may delay fruit maturity, reduce fruit quality and adversely impact postharvest life. Beside this, flood, drought, hail storm adversely affect the production of horticultural crops.

3. Technological options for climate resilient horticulture production

3.1 Selection of appropriate crop based on climatic and soil suitability

Selection of appropriate horticultural crops based on land, soil and climatic suitability is important for maximization of overall increase in production of horticultural crops in the country. For sustainable development and realization of high productivity levels, crop planning based on agro ecological considerations and efficient use of inputs has been attempted, only with partial success. The success story of the Konkan region in the Western Ghats in commercialization of mango, cashew, black pepper, etc. demonstrates the possibility of converting once barren hilly tracts into economically viable regions (1). Similarly, there are immense scopes of selecting drought tolerant crops plant in various parts of Bihar. Selection of tolerant varieties to various abiotic and biotic stresses will sustain in changing climate scenario.

3.2 Optimization of land use

Techniques like fruit based multitier cropping systems has proven their effectiveness for improving the land use efficiency through better utilization of land, space and solar radiation. The multitier cropping system comprise of a combination of perennial and annual plant species as different components in the same piece of land arranged in a geometry that facilitates maximum utilization of space in four dimensions (length, width, height and depth) leading to maximum economic productivity of the system (2). Nimbolkar et al (2013) described the general architecture of the fruit based multitier cropping system and existing fruit based multitier cropping systems in various agro-climatic zones of India. Land use systems based on mixed tree crops have clear advantages over annual cropping systems for the maintenance of soil fertility in the humid tropics. Due to climate uncertainty, if one component fails to survive in multitier cropping system, other component supplements income.

Emission of greenhouse gasses is one of the causes of climate change. Multitier cropping system found is beneficial for mitigation of climate change by carbon sequestration (4). Tree components in fruit crop based multitier cropping system can be significant sink of atmospheric carbon due to their fast growth and high biomass production. Fruit tree based cropping system can arguably increase the amount of C stored in the lands devoted to agriculture while still allowing for growing of food crops.

3.3 Green manuring and cover cropping

Growing cover crops and green manure crops can be viewed as a type of crop rotation, where adding nonrevenue generating crop between annual cash crops extends the growing season. Green manures, also referred to as fertility building crops, may be broadly defined as crops grown for the benefit of the soil. The terms cover crop and green manure are frequently used synonymously. Florentín et al (2010) reported the following benefits of green manuring and cover cropping: (1) Add organic matter to the soil, (2) Increase soil biological activity, (3) Improve soil structure, (4) Reduce soil erosion, (5) Increase the supply of nutrients available to plants (particularly by adding nitrogen to the system by fixation), (6) Reduce leaching losses, (7) Suppress weeds, (8) Reduce pest and disease problems, (9) Provide supplementary animal forage, (10) Drying and warming the soil.

3.4 Efficient water management

Due to increasing population and shrinkage of natural resource especially water, Indian population would face severe water scarcity. Water supply for horticultural crops will face more intense competition among the multiple users of water. Furthermore due to climate change, drought is frequent phenomenon to Indian condition. Therefore, increasing water use efficiency for horticultural crops will need attention to mitigate the problem. The strategies for increasing water use efficiency include appropriate integrated land and water management practices like: (1) appropriate scheduling of irrigation, (2) soil–water conservation measures through adequate land preparation for crop establishment, rainwater harvesting and crop residue incorporation, (3) efficient recycling of agricultural wastewater, (4) conservation tillage to increase water infiltration, reduce runoff and improve soil moisture storage, and (5) adequate soil fertility to remove nutrient constraints for maximizing crop production for every drop of water available through either rainfall or irrigation. In addition, novel irrigation technologies such as supplementary irrigation, deficit irrigation, drip irrigation and sprinkler irrigation can improve the water use efficiency of crops.

Drip irrigation practices are becoming popular now-a-days in horticultural crops due to their beneficial effects on water use efficiency and yield which has been successfully demonstrated in different parts of the country (6, 7, 8). Since drip irrigation is a high capital-intensive technique, there are quite a few doubts among the farmers about its net profitability. No doubt, the initial capital investment for drip irrigation system is high. However, the fixed investment is not very high when compared with the benefits realized from the drip method of irrigation. For instance, per hectare cost comes to about Rs. 33,000 for banana, while the same varies only from about Rs. 9,000 to Rs. 16,000 for other crops like coconut, mango, grapes, pomegranate, etc. Though, the initial cost of drip irrigation system is higher, its relative cost is quite low when compared with the average capital cost in the surface system.

3.5 Mulching

Mulching is an effective technique for minimization of evaporative losses. Use of plastic mulches has been successfully demonstrated to increase yield and quality of different horticultural crops (9, 10). Extensive research with coloured mulches has been conducted the experience so far clearly indicate scope of colour mulches under Indian conditions (11). The most serious problems associated with plasticulture relate to removal of used plastics from the field and its environment friendly disposal. Biodegradable plastics are made with starches from plants such as corn, wheat, cassava and potato. They are broken down by microbes. Biodegradable plastics currently on the market are more expensive than traditional plastics, but the lower price of traditional plastics does not reflect their true environmental cost. Application of externally produced organic mulches affects crop growth by influencing weed growth, soil conditions, soil nutrient status, and soil erosion. If weeds are likely to reduce crop yields, organic surface mulches might be able to suppress their growth by hindering and delaying germination (emergence) through shading. On the other hand, mulch may enhance soil conditions for plant growth in general so that also weeds are favoured.

3.6 Protected Cultivation

Protected cultivation of horticultural crops is also another approach for increasing land use along with resource use efficiency. The main purpose of protected cultivation is to create a favourable environment for the sustained growth of crop so as to realize its maximum yield potential even in adverse climatic conditions. Protected cultivation technology offers several advantages to produce vegetables, flowers, hybrid seeds of high quality with minimum risks due to uncertainty of weather and also ensuring efficient and other resources. This becomes relevant to farmers having small land holding who would be benefitted by a technology, which helps them to produce more crops each year from their land, particularly during off season when prices are higher. Thus, protected horticulture has great potential to enhance the income especially of small farmers if appropriate technological interventions are made. Ummyiah et al (2017) described in details about the various Protected Cultivation technologies such as net houses, walk-in-tunnels, greenhouses etc. suitable for temperate regions with suitable crops that can be successfully grown even in low temperature in those structures.

3.7 Grafting

Grafting is a method employed to improve crop production. The first grafted vegetable seedlings used were for Watermelon (*Citrullus lanatus* L.) plants grafted onto *Lagenaria siceraria* L. rootstock to overcome Fusarium wilt. Since then, the use of grafted solanaceous and cucurbitaceous seedlings has spread. The expansion of grafting is likely due to its ability to provide tolerance to biotic stress, such as soil borne pathogens, and to abiotic stresses, such as cold, salinity, drought, and heavy metal toxicity, due to the resistance found in the rootstock. In India under project NICRA, IIHR have identified solanum root stalk which is used for tomato grafting. Grafted plant was found to be tolerant to flood condition. Mauyra et al (2019) described various grafting methods suitable for vegetable crops.

4. Conclusion

Many technologies related to climate resilient horticulture described in this article are available which need to be demonstrated and implemented in farmer's field for sustainable income. These technologies address at least address one of the Sustainable Development Goals such as fruit based multitier cropping system ensures food and nutritional security as well as sustainable agriculture, green manuring and cover crops reduces land degradation, adoption of efficient water management techniques reduce use of water for agriculture and thus increase environmental water availability and so on. Although some of the techniques such as Protected Agriculture is costlier, long term use of them can be remunerative.

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