

Role of Agricultural Biotechnology to Mitigate Climate Change

Nupur Mondal* and Seema Talwar

¹Assistant Professor, Shivaji College; 8750368798

²Assistant Professor, Shivaji College; 9990426595

E-mail: *nupur.mondal2010@gmail.com; seematalwar2014@gmail.com

Abstract—Climate change is one of the biggest challenges of twenty-first century as it is not only going to affect humankind directly, but by affecting the different regions of the globe differently, it will cause changes in agricultural ecosystems. Developing countries having tropical climate will be more severely affected as increasing temperature and drought conditions will increase the demand for water. A slight increase in temperature will affect the yields of crops in colder temperate regions as well. Grains and oilseeds will mature faster whereas, in horticulture, tomatoes, onions and fruits might be produced of low quality because of climate change. Developing countries which are densely populated, are going to be adversely affected and would experience severe food insecurity. Agriculture is one sector which not only causes climate change itself, but is also affected in worst way by climate change. There is an increased demand for use of biotechnological tools to help crops adapt to the various climatic changes which will not only help these crops to survive in adverse conditions but will also save humankind from severe food insecurity.

Introduction

Humankind is facing one of the most important challenge in form of climate change. This is a challenge because it is resulting in increasing temperature and rise in sea level. Climate change is caused due to release of greenhouse gases in the atmosphere. This when accumulates in nature leads to increase in temperature. Climate change is responsible for many changes in temperature, rainfall, sea level and moisture of soil.

It is anticipated that Asia will be affected by drought. Moreover, Himalayan glaciers might melt leading to loss of water in rivers and streams [1]. The temperate zones of world, like North America and Europe are expected to be hit by hurricanes and floods. Hence, all these changes will directly affect agriculture and thereby, indirectly effect the livelihood of billions of people who majorly constitute the poor of developing countries. The agriculture sector not only contributes to climate change but also is adversely affected by it.

Human intervention is required to reduce the sources of climate change or to decrease the negative effects of the climate change, which is also known as climate change

mitigation. Thereby, there is a need for either increasing the sink or decreasing the source of climate change. It has become clear that there is a need for mitigating climate change so that humankind can feed himself in the next decade in such a constraint. We must use ways to combat global warming and to feed billions of people in this less favourable conditions. Increasing forest cover, switching to renewable energy, less usage of fossil fuels are one of the few ways by which we can mitigate climate change [2]. Agricultural biotechnology uses techniques like tissue culture, molecular markers, genetic engineering and conventional breeding for creating specialized crops which are resistant to the severe environmental changes. In this paper, we are going to discuss about the various methods of agricultural biotechnology by which we can mitigate climate change.

Energy efficient farming

Biofuels are fuels derived from plants and plants derived products. They can be of two types: bioethanol and biodiesel. In road transport vehicles, bioethanol is mainly used as a substitute, which is derived from sugarcane and maize. On the other hand, oilseed crops like rapeseed and palm are used for production of biodiesel. Plantation of non-edible oilseed crops which are perennial for production of bio-diesel, will help in less polluted atmosphere because of less usage of fossil fuels [3,4,5]. Switching to green energy will boost the income of farmers as revenue required for importing fossil fuels is saved. By using various means of biotechnology, increase in yield of plants involved in production of biofuels has been possible. Compost and animal manure use, intercropping of plants with leguminous plants which are also efficient nitrogen fixers, are few old biotechnological tools by which we can combat climate change.

Crop Adaptation

As the temperature will increase, there will be an increase in demand of water by plants [6]. With various biotechnological tools, like physical mapping, whole genome sequencing of plants, functional genomic tools etc., stress tolerant plants can be made [7]. Knowledge of various genes and alleles related to

stress biology, can be found using bioinformatics and molecular biology. Genetic engineering can be used to transfer genes across barriers of different kingdoms, families and species. Hence, crops resistant to various abiotic stresses has been made to survive climate change.

Some genes give tolerance to a range of abiotic stresses like drought, salt, cold and low phosphorus. Transcription factor (OsDREB1A) in sugarcane was on trial till 2015 [8]. Other genes found in various plants giving tolerance to salt may prove to be essential in plants like rice, barley, wheat, tomato and soyabean [9, 10]. In many plants help of structural genes, regulatory genes and transcription factors have been taken to develop stress tolerant plants. Transgenic crops have been developed in rice, maize, sugarcane, tobacco, tomato etc. carrying different drought tolerant genes. It has also been found that heat shock proteins help plants to recover from heat stress and even drought.

Biofortified foods

Creation of transgenic plants or by altering general physiology of plants, we can create better crops with increased amount of vitamins and minerals. Humankind can benefit a lot by consuming biofortified food as the staple food of poor people has been tried and modified to give enhanced nutrition [11]. This can save people from many diseases and can benefit human health especially heart, bones, eyes, brain and in maintaining weight. Earlier we have already heard of iodized salt and vitamin D enriched milk, but nowadays, we can also find calcium- and vitamin D enriched fruit juices, omega-3 fatty acid enriched breads, plant sterols containing bread spread etc.

Biofortified foods can be easily incorporated in food habits of poor people. This will not only enhance human health but will also give a solution to feed increasing population affected by climate change.

Conclusion

Climate change can be positively affected by biotechnology as it can help in mitigation by reduction of CO₂ emission, less fuel usage, use of composts, manures, less artificial fertilizer usage, improving soil fertility etc. Crops improved by increased resistance to climate change will help combating the increasing population demands. Modern agricultural biotechnology and conventional approaches will contribute in creating better resilient crops of high yield and nutrition which can give food security and can significantly mitigate climate change.

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