



ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(1): 582-584
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www.thepharmajournal.com
Received: 29-11-2017
Accepted: 30-12-2017

GN Gurjar

Ph.D Research Scholar at School of Natural Resource, Management, Central Agricultural University, CPGS, Umiam, Meghalaya, India

Sanjay Swami

Associate Professor at School of Natural Resource Management, Central Agricultural University, CPGS, Umiam, Meghalaya, India

V Ram

Professor (farming system research), Central Agricultural University, CPGS, Umiam, Meghalaya, India

NK Meena

Ph.D Research Scholar at School of Social Science, Central Agricultural University, CPGS, Umiam, Meghalaya, India

N Laitonjam

PhD research scholar at school of social sciences, Management, Central Agricultural University, CPGS, Umiam, Meghalaya, India

Correspondence

GN Gurjar

Ph.D Research Scholar at School of Natural Resource, Management, Central Agricultural University, CPGS, Umiam, Meghalaya, India

Climate change and critical research needs regarding climate, carbon-dioxide and crop production

GN Gurjar, Sanjay Swami, V Ram, NK Meena and N Laitonjam

Abstract

Climate change is the most important issue at national as well as at global level. The climate changing due to many reasons which directly change in the concentration of many gases specially carbon dioxide and increase in the intensity of precipitation and also increase in the global temperature. These changes in the levels of carbon oxide and temperature leads to change in our production and productivity of crops plants special reference to agricultural crops which are very sensitive to change in temperature and concentration of greenhouse gases like carbon dioxide. So to take a sustainable production from agricultural crops under changing climate scenario, we have to focus on new techniques of crop production. These new techniques are like changing in the research. The critical research on agricultural crops related to impacts of high temperature and carbon dioxide concentration. These are some important sector of research which are sustainability of crop production, water supply, input supply, food safety, plant varieties etc. all the above sectors of research require a new research techniques of experiment to suit accordingly changing climate. Those all sectors need a new experiment to maintain our sustainable food production to supply food for increasing global population especially for Asian countries under changing climatic. So, we have to focus on such new research area under high levels of CO₂ to get higher production in both the sense of quality and quantity.

Keywords: Climate change, agriculture, sustainability, critical research, CO₂

Introduction

Climate change is the long term change in the climatic pattern related to weather phenomena. Changing in the climate will cause certain modification in the environment where all living and non-living things are existing. Because of climate change, mainly increase in the concentration of carbon dioxide and temperature of the planet. Among both the factors, change in carbon dioxide gas concentration leads to many harmful impacts on agricultural crop production which have direct and indirect impact on production of rice, wheat, maize, sorghum, cotton, potato, sugarcane and on others cash crops like tobacco, opium, jute etc. Because of change in concentration of carbon dioxide we needs to focus on research activities related to crop production in changing climate scenario and what will be the reduction or increase possible in the end of 21st century. According to changed and changing climate certain steps or improvement in research technique will be required as water supply for agricultural crop production, sustainability of crop production, food security and agricultural trace gases etc.

Critical Needs: There are number of certain critical research needs related to increased concentration of carbon dioxide (CO₂) and its direct relation to crop production. Some of the critical needs are given below as –

1. Sustainability of crop production: Crop production is totally depends upon the climatic conditions of a particular region or country which will be in favour to crop growth and development. But the impacts of short term changes in weather activities have more impacts than long term impacts in certain situations i.e., daily change or seasonal stress conditions. According to climatologists prediction about global climate change extremes are including total precipitation, frequency of drought occurrence as well as increased high temperature conditions. These changes in climate could be able to change in the crop production directly due to increased level of carbon dioxide gases. There are a little research have been conducted about climate change impacts on crop production special reference to elevated concentration of carbon dioxide and under drought and temperature stress condition.

So the current yield prediction is highly variable and uncertain due to lack of research. Research is needed to reduction in uncertainty and proper prediction of future agricultural crop yields.

2. Agricultural water supply: The crop production without irrigation facility is nothing, so we have to improve in water supply for agricultural crop production to get perfect on prediction about crop yield. To maximize agricultural crop production and to fulfil the food requirement of present and future population of the world, it is necessary to improve in agricultural water supply for accomplishing food requirement. The availability of irrigation water is depends upon fresh water available in the form of fresh water sources including snow and ice collected on mountain ranges. According to available research data suggest that human induced global warming has playing important role on precipitation and temperature are increased which have certain impacts on water source but also have negative impacts on crop production under rainfed areas due to flooding from increased precipitation results in disruptions. The research helps in identification of specific adaptation measures, water extremes will negatively impact food availability for humans.

3. Input supply (fertilizers and energy): Maximization of crop production is depends upon the adequate supply of inputs like fertilizers especially nitrogen as well as energy required to carry out different farm operations. The nitrogenous fertilizers likely to be more susceptible to different kind of losses which cause many impacts on the agro – ecosystem like nutrient enrichment of water sources (ponds, lakes etc.). There is a urgent need to ensure that the fertilizers used in agricultural crop production will be based on fossil-fuel. The application of fossil fuel based fertilizers to supply plant nutrients will be a difficult task but its not impossible.

4. Food safety: The climate change will increase in the average temperature due to increase in concentration of some important gases like carbon dioxide and the increase in the precipitation. The climate change will have certain impacts on habit and habitat of micro-organisms specially related to pathogenic bacteria like E. coli and salmonella. There is positive relation between these bacteria and temperature which results in outbreaks of E. coli and salmonella pathogenic bacteria. The scientific analysis of the likely impacts and preventive measures is needed.

5. Selection of plant varieties: The selection of crop varieties is most important tool to maintain crop yield under changing climate scenario because crop varieties are specific to a particular climatic condition. Now a day's temperature and precipitation are increasing and crop yield of certain crops are decreasing, to mitigate this impact we have to introduce new crop varieties those are performing better under high the temperature and precipitation conditions. Among the existing crop biotypes could be a second option to exploit the increasing carbon dioxide (CO₂) to maximize crop production of cereal crops and oilseeds like Indian mustard. At present, there is no such system which is systematically evaluating the available genotype or phenotypes were under cultivation. It is compulsory to develop a systematic evaluation patterns to maintain agricultural crop production and sustainability of agriculture, without such system agriculture is at high risk.

6. Alien species in Agriculture: The introduction of new plant species of weeds are creating problems in crop production which leads to increase in cost of production and will be able to create a huge disaster on the sustainability and economic costs of crop production. The total cost on management of invasive species in agriculture was estimated around 138 billion (US dollar) every year (Pimentel *et al.*, 2000). Such kind of alien species are limited only by the climatic conditions. How the increased concentration of carbon dioxide and average temperature will favour the growth and development of such alien species? For example Ug99 is a well-known and potentially invasive strain of wheat black rust that have been developed the resistance mechanisms to the changing climate and become a biologically successful invasive species in the world agriculture. But we do not have any historical data about the past and present of that particular species survival in and now also how that strain is surviving under the changing climate scenario? We have to focus on such alien species those are highly important in crop production but no one has been did work about economic losses caused due to such species in agriculture specially related to climate change and their survival mechanisms.

7. Species shift in rangelands: The climate change is increasing in the temperature and precipitation will have certain impacts on global agriculture and affect the crop production mainly. Because of changing in average temperature and precipitation pattern, the plant biotypes are also changing in their physiology according to temperature and availability of water and such change will cause species shift from agricultural lands to rangelands. Plant species are having different sensitivity to temperature, rainfall and carbon dioxide, it is already suggested by researchers that some species of plant are shifting over others in rangelands. So there is need to better understand species shift towards rangelands and what are the management practices or methods required to manage such species in agricultural lands. We need to apply such knowledge for developing proactive strategies of management that will make easy management of range and public land managers adapt to changing climate of the Earth planet.

8. Greenhouse gases (GHGs): Climate change is happening due to increased gaseous concentration in the earth's atmosphere which utilize fossil fuels burning as a source of energy required for different agricultural chemical production and industrial purpose. Agriculture sector contribute in global climate change through releasing greenhouse gases like methane (CH₄) from paddy fields. Agriculture is also act as both source and sink of greenhouse gases, depending upon a particular agricultural activities or enterprise. Currently around 40 % of greenhouse gases are released into the atmosphere every year which are captured back by terrestrial ecosystem and fixed into different compounds, those captured part of greenhouse gases are not active or behave like GHGs i.e., do not contribute in any kind of climate change. There is very less information available about how different agricultural enterprises are contributing in greenhouse gases production and how such contribution of agriculture towards climate change will be reduced i.e. lack of modified methods or cultural practices we should use to minimize contribution of agriculture in climate change say GHGs. Research about how different agro-ecosystem and various management

practices affecting the release of greenhouse gases and their exchange mechanisms are needed to learn how agriculture will be able to reduction in its terrestrial emission of greenhouse gases into the earth's environment.

9. Soil Biology (organisms): Microorganisms play a vital role in decomposition of organic plant materials and significantly contribute into the nutrient mineralization, immobilization processes and their availability to plants i.e. nutrient uptake. So many aspects of crop production is depends upon beneficial organisms (like bees, earthworms, micro-organisms). To see the impacts of climate change on behaviour of such micro-organisms particularly to increased temperature, rising concentration of carbon dioxide is needed. There is no information or research data are available about temperature and CO₂ impacts on beneficial micro-organisms. So, it is needed to do research on impact of CO₂ and temperature on life-cycle, abundance and effectiveness of such organisms and what will be the overall impacts of climate change on soil biological properties with respect to crop yield and agricultural point of view.

10. Development of Agro-technology and communications: Climate change impact and its significance in crop production is limited to researchers, still farmers are not fully aware about these changes and how these are directly and indirectly related to crop production. It is really necessary to develop a strong and effective communication technology which provides the all information from researchers to farmer's community. It should be easy to understand and practical for farmers, so they can change in their farm practices and also cost effective. Most of the techniques were developed in the past few decades are not that much effective and most of them are not developed according to climate change. Research is needed to do in such a way that is more applicable in agricultural sector especially for crop production. It also helpful for policy makers and lay publically successful. Communication of current sciences is needed towards public sector also.

Conclusion

Climate change is become an international issue due its vast impacts of crop production as well as on others sectors. So, there is most important and urgent need to look into the vulnerability of crop production to changing climate scenario. The green revolution based farming approaches are no longer effective in the present and future day of changing climate. There is need to do research on impacts of increased temperature and carbon dioxide concentration on sustainability of agriculture. To seek for development of new research technology according to their suitability in changing temperature and raised CO₂ level. Such techniques are able to assess how climate change affecting agricultural crop yield and what management practice we should use to get more crop yield by utilizing increased level of CO₂ and how these practices are minimizing contribution toward climate change and a number of techniques can be implemented to adapt to these changes.

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