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Review Article

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Global Warming: Its Impact and Implication on Field Crop Production

Rajdeep Mundiyara* and Prem Kumar, Mamta Bajya and Leela Bhat

Seed Officer, Rajasthan State Seeds Corporation, Mandore, Jodhpur, Rajasthan, India

*Corresponding Author E-mail: rmundiyara5@gmail.com

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ABSTRACT

Global warming refers to a rise in the temperature of the surface of the earth. An increase in the concentration of greenhouse gases leads to an increase in the magnitude of the greenhouse effect (called enhanced greenhouse effect). Climate change is now unequivocal, particularly in terms of increasing temperature, increasing CO_2 concentration, widespread melting of snow and ice, and rising global average sea level, while the increase in the frequency of drought is very likely but not as certain. Climate change will affect forest genetic resources via many different demographic, physiological and genetic processes. Extreme climatic events that kill large numbers of trees may become more common. More gradual changes in temperature and precipitation may inhibit the capacity of forests to regenerate. In some places, pest and disease attack may become more severe because climatic conditions become more favorable for the attacking species or because climate induced stress makes trees more susceptible to attack. This results in global warming. Global warming is the observed century-scale rise in the average temperature of Earth's climate system. Since 1971, 90% of the increased energy has been stored in the oceans, mostly in the 0 to 700m region. Despite the oceans' dominant role in energy storage, the term "global warming" is also used to refer to increases in average temperature of the air and sea at Earth's surface. Since the early 20th century, the global air and sea surface temperature has increased about 0.8 °C (1.4 °F), with about two-thirds of the increase occurring since 1980. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. IPCC stated that the largest driver of global warming is carbon dioxide (CO_2) emissions from fossil fuel combustion, cement production, and land use changes such as deforestation.

Key words: *Global Warming, Temperature, Earth, Forest, Genetic Resources.*

INTRODUCTION

Solar radiation passes through the atmosphere and warms the Earth's surface. The Earth emits thermal radiation (also called infrared radiation) back to space, part of which is absorbed by the molecules of "greenhouse gasses" (water vapor, H_2O; carbon dioxide, CO_2; some other micro gases) in the atmosphere and warms the atmosphere. This warming effect of the greenhouse gases is called the "Greenhouse Effect".

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A gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, CFCs (chlorofluorocarbons), and other pollutants. The "greenhouse effect" & global warming are not the same thing. Global warming refers to a rise in the temperature of the surface of the earth. An increase in the concentration of greenhouse gases leads to an increase in the the magnitude of the greenhouse effect (called enhanced greenhouse effect). This results in global warming. Global temperature during the 20th century increased by 0.6 ± 0.2°C @ of 0.17°C per decade since 1950.

The additional greenhouse effect caused by the additional greenhouse gases in the atmosphere due to human activities (fossil fuel burning; deforestation, etc) If there were no greenhouse gases (hence no greenhouse effect) the Earth's temperature would be -18°C (not +15 °C as it is at present).

Table 1: Green house gases and their contribution to global warming (IPCC, 2007)

Green house gases	Atmospheric conc. (ppm)	Lifetime (yr)	GWP (relative to CO_2)	Sources
CO_2	379	5	1	Fossil fuel combustion 1and use, biomass burning, etc.
CH_4	1.72	12	32	Biomass decomposition, wetland paddies, swamps, marshes, peat lands, etc.
N_2O	0.31	114	150	Fertilizer use, fossil fuel combustion, biomass burning flooded soil
O_3	Variable	2-5days	2000	Reactions involving pollutants such as CH_4, NO_2, CFCs and sunshine
CFC-12	527ppt	100	10,000	Aerosols, refrigerator
SF6	7.79ppt	3200	22800	Human activities
NF3	326ppb	740	17200	Human activities

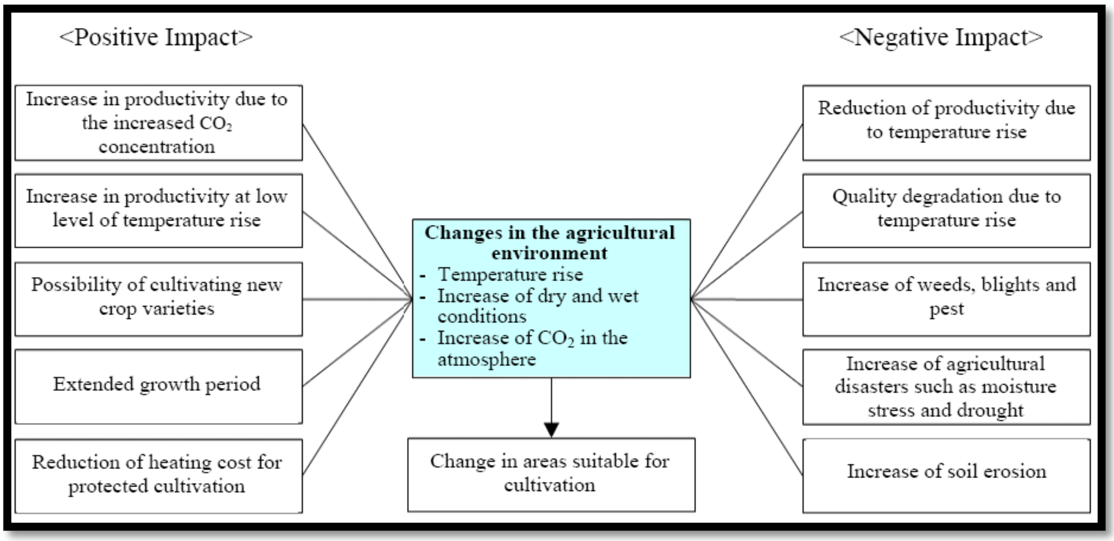

Fig. 1: Potential impacts of global warming on the agricultural sector[2]

Impact on crop production

High Temperature

Positive impact:

- Reduced Cold & frost event

Negative impact:

- Reduced yield due decrease grain filling period
- Increase respiration
- Increase extreme weather condition i.e. drought, heat wave
- Increase evaporative losses

High CO_2

- Decrease evaporative losses
- Increase yield in c3 plants e.g. rice & wheat
- Adverse affect on quality of fruits

Other

- Increase rate of organic matter decomposition
- Lower organic matter content & quality
- Decrease nitrogen availability
- Extent of soil erosion
- Salt –water problem in coastal land
- Changes in seasonal precipitation & patterns
- Moisture stress
- Lowering water table
- Melting of glacier increase water in rivers
- Affect quality of ground water due to intrusion of sea water
- Increase runoff in wet season

Impacts of Global Warming

1.CO_2 effects on yield components and grain composition affecting quality

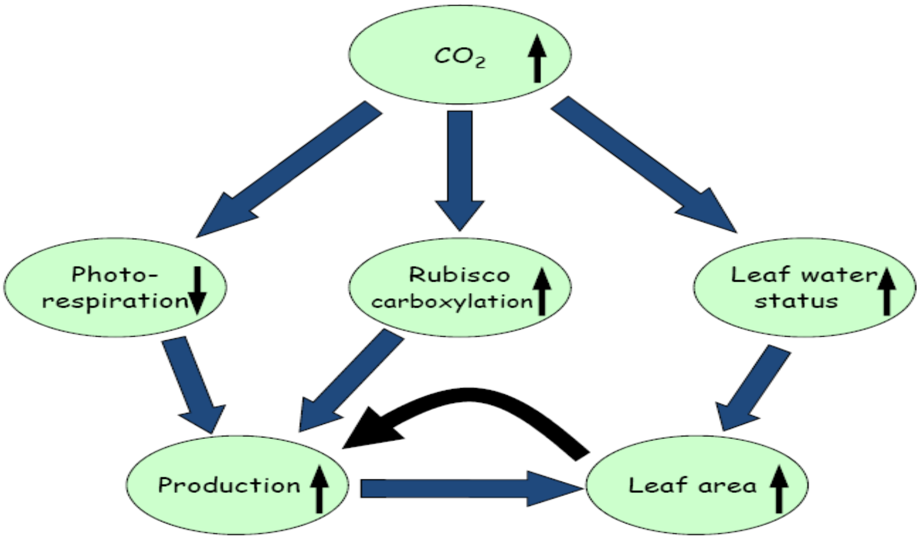

Fig. 2: CO_2 concentrations stimulate photosynthesis in many crops

2. *CO_2 effects on yield components and grain composition affecting quality*

Since several significant impacts of CO_2, exposure system, rooting volume or interactions between these parameters were observed for grain quality traits.

3. *CO_2-induced responses of wheat grain proteins and protein components*

The average relative effects of elevated CO_2 (550 vs. 380 mmol mol^{-1}) on protein concentration. Overall, the total gluten concentration as well as concentrations of dry and wet gluten decreased under CO_2.

4. *CO_2-induced impacts on non-protein components*

The mean responses of macro-elements to CO_2 enrichment were decreases in concentration by 0.7–19.5%, except for K and P which increased by 3.9 and 1.1%.

5. *Responses of wheat yield components to atmospheric CO_2 enrichment*

In terms of wheat productivity, elevated CO_2 was shown to increase yield components, with increases in TGW, grain number per ear[4] or the number of flowering tillers per unit ground area.

6. *Effects of CO_2 enrichment on the composition and quality of wheat*

Physiological background CO_2-induced increase in wheat biomass and grain yield is associated with changes in nutrient metabolism, resulting in significant changes in the chemical composition of different plant organs (Idso, 2001). The CO_2-induced decrease in N concentration is largely the result of the accumulation of carbohydrates and other organic compounds in leaves and possibly other organs as a result of the stimulation of photosynthesis (Kimball, 2004). In addition, elevated CO_2 predominantly reduces the amount and activity of foliar ribulose-1,5-bisphosphate carboxylase/oxygenase (RubisCO)[1]. Thus, reallocation of N away from RubisCO to light harvesting and sucrose synthesis will increase NUE [5] as ribulose-1,5-bisphosphate- (RuBP) and inorganic orthophosphate- (Pi) regeneration will limit the CO_2 assimilation rate under CO_2 enrichment.

7. *Effects of CO_2 Increase in Combination with Temperature Increase*

There could be beneficial interaction of CO_2 enrichment and temperature on dry matter production (greater response to CO_2 as temperature rises) for the vegetative phase of non-competitive plants. This effect may be beneficial to production of radish (*Raphanus sativus*), lettuce (*Lactuca sativa*), or spinach (*Spinacea olervicea*), mainly because any factor that speeds leaf area growth (whether CO_2 or temperature) speeds the exponential phase of early growth.

8. *Interactions of Elevated CO_2 with Nitrogen Fertility*

For non-legumes like rice, there is clear evidence of an interaction of CO_2 enrichment with nitrogen (N) fertility regime. For *japonica* rice, Nakagawa *et al.*[6] reported 17, 26, and 30 percent responses of biomass to CO_2 enrichment, at N applications of 40, 120, and 200 kg N ha^{-1}, respectively.

9. *Effects of CO_2 Increase on Water Use and Water Use Efficiency*

When plants are young and widely spaced, increases in leaf area are approximately proportional to the increases in growth, and transpiration increases accordingly. More importantly, duration of leaf area will affect total seasonal crop water requirements. Thus, the lengthening of growing seasons due to global warming likely will increase crop water requirements. On the other hand, for some determinate cereal crops, increasing temperature can hasten plant maturity, thereby shortening the leaf area duration with the possibility of reducing the total season water requirement for such crops. Elevated CO_2 causes partial stomatal closure, which decreases conductance, and reduces loss of water vapor from leaves to the atmosphere.

10. *Temperature effects on crop yield*

Yield responses to temperature vary among species based on the crop's cardinal temperature requirements. Plants that have an optimum range at cooler temperatures will exhibit significant decreases in yield as temperature increases above this range. However, reductions in yield with increasing temperature in field conditions may not be due to temperature alone, as high temperatures are often associated with lack of rainfall in many climates.

CONCLUSION

It may be concluded that we should try to reduce the emission of greenhouse gases by indiscriminate burning of fossil fuels and other human activities which raise GHGs emission and try some carbon sequestration technologies so that the released CO_2 can be trapped again in the soil or other reservoirs to mitigate the effects of climate change. Breeding approaches have the potential to contribute to reduced emissions of nitrous oxide and methane from both grazing animals and the soil, as well as directly from the plant and to boost the capture (sequestration) of carbon in the soil. A key area where genetic approaches can have an impact is in improving the nitrogen use efficiency (NUE) of crops to allow lower fertilizer application and, hence, reduce N_2O emissions throughout the soil-plant-(animal)-soil cycle.

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