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4. Climate Change and Its Impact on Agricultural Seed Production and Quality

Anubhav Thakur

PhD Scholar,
Department of Seed Science and Technology,
Dr. YSPUHF Nauni,
Solan, H.P.

Tarun Sharma

PhD Scholar,
Department of Agronomy,
CSKHPKV Palampur.

N. K. Bharat

Principal Scientist,
Department of Seed Science and Technology,
Dr. YSP UHF,
Nauni, H.P.

Rajesh Kanwar

Assistant Professor,
Department of Seed Science and Technology,
CSKHPKV,
Palampur, H.P.

Ojas Chauhan

PhD Student,
Department of Entomology,
Dr. YSP UHF,
Nauni, H.P.

Abstract:

Climate change is the biggest threat to human civilization in 21st century and it has direct impact on agriculture seed production. Due to climate change the concentration of CO_2 is increasing in atmosphere and it is expected to reach 550ppm by end of 21st century. It has direct impact on seed production and seed quality. In this chapter we have discussed the effect of elevated temperature and CO_2 on seed germination, vigour, and weight and seed production. To mitigate the effect of climate change we need to develop varieties, which can

be grown at higher CO_2 concentration and high temperature. Seed industry also needs to develop the strategies to feed the 9 billion people by 2050. They have to identify new seed production areas, novel seed quality enhancement techniques to mitigate the climate change.

Keywords: *Climate Change, Seed, Seed production.*

4.1 Introduction:

Seed security is important for food security (Hampton et al. 2016). Seed is the repository of the genetic potential of crop species and continues use of quality seeds results in increase of food production (FAO, 2009). Seed industry plays an important role in providing high quality seeds of high yield varieties and increasing the food production (Singh et al, 2013a). The global seed market is currently valued around USD 80.88 billion (Anonymous 2022). Keeping the other factors constant, the quality seed of HYVs can increase the crop yield by 15-20% (Agrawal, 2011). In last five decades seed production in major field crops has been increased by 1-3% per year due to continuous advancement in field of plant breeding (Bruins, 2009). But the changing climate could have huge impact on seed production. In this chapter we will discuss about the impact of climate change on seed production in various crops.

4.1.1 Impact of Elevated Temperature on Seed Yield:

The effect of elevated temperature on seed yield has been studied in various crops like soybean, cotton, and rice, peanut and also on some forage legume and grasses (Singh et al, 2013b). Increased CO_2 has increased the seed yield by 11-13% in crops like wheat but it has no impact on leave yield in maize (Jaggard et al, 2010; Hatfield et al, 2016). This increase in yield is due to presence of greater number of seeds per unit area (Quaderi and Reid, 2005). Higher temperature also promotes plant metabolism and change the rate of organ development, respiration, senescence and source –sink relationship (Farrar and Williams, 1991).

In case of forage legumes like white clover and ryegrass, elevated temperature had shown increase in flower number and decrease in time to emergence in some cultivars (Deckmyn et al, 2001). In case of vegetable crops like carrot and radish, elevated carbon dioxide increased the vegetative growth and seed production (Idso et al, 1989; Curtis et al, 1994). In *Brassica oleracea* increasing temperature from 17°C to 26º C had significantly reduced the seeds per pod (Murabaa 1957).

4.1.2 Impact of Elevated Temperature and CO_2 on Seed Quality:

Seed quality consists of many parameters like seed germination, physical purity, genetic purity, viability, vigour, seed health and morphological characters like shape, weight size (Maity et al, 2016). Each of this parameter is severely affected by change in environment. Elevated temperature has different effect on seed germination in different species. Higher concentration of CO_2 increases the ethylene production which can promote seed

germination in many species (Ziska et al, 1997). Other seed quality parameters like seed size and weight are also get changed when environmental conditions are not favorable. Some studied have shown that elevated CO_2 have enhanced the seed weight because of greater availability of assimilates (Lamichaney and Maity, 2021). Rising temperature and CO_2 also have effect on seed vigor. According to finding of Lamichaney et al. (2019) higher concentration of seed vigor (610ppm) have significantly reduced the seed vigor in rice. Biochemical composition of seed is also affected by higher temperature and CO_2 concentration in some species.

Higher concentration of CO_2 has reduced the seed nitrogen content and phosphorus, calcium and sulphur in chickpea seed (Saha et al, 2015; Zheng et al, 2020).

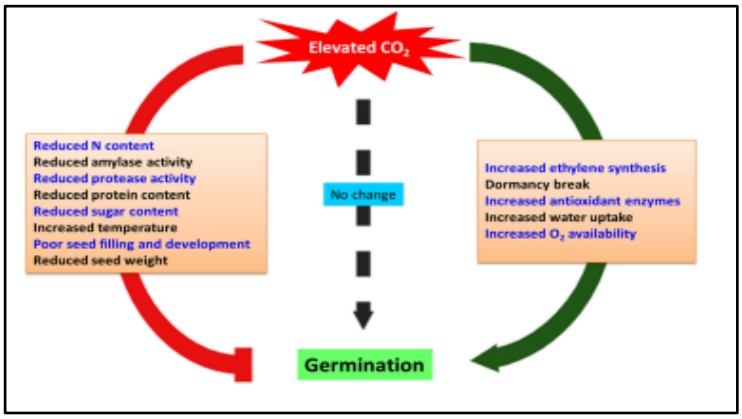

Figure 4.1: Elevated CO_2 and Its Effect on Seed Quality

4.2 Conclusion:

Till the end of end of 21st century, changing environment will be the biggest issue faced by the human being and agriculture will be most affected industry from this. Elevated temperature and CO_2 concentration will have direct impact on seed production and seed quality. Therefore it is necessary to conduct more research in these areas. We need to developed varieties which can produce higher seed yield at high CO_2 concentrations. Seed industry also needs to develop the strategies to feed the 9 billion people by 2050. They have to identify new seed production areas, novel seed quality enhancement techniques to mitigate the climate change.

4.3 References:

1. Anonymous (2022). www.mordorintelligence.com/industry-reports/commerical seed market
2. Agarwal (2011). Climate change and its impacts on agriculture. In: Sovenir- Indian Seed Congress, Feb 22-23rd, Hyderabad pp 67-76
3. Bruins M (2009). The evolution and contribution of plant breeding to global agriculture. In Proceedings of the Second World Seed Conference, Rome, Italy, 8–10 September 2009; pp. 18–31

4. Curtis PS, Snow AA, Miller AS (1994). Genotype-specific effects of elevated CO_2 on fecundity in wild radish (*Raphinus raphanistrum*). *Ocecologia* 97:100-105
5. Deckmyn G., Caeyenberghs E, Ceulemans R. Reduced UV-B in greenhouses decreases white clover responses to enhanced CO_2. *Environment Experimental Biology* 46:109-117
6. Farrar, JF Williams ML (1991). The effects of increased atmospheric carbon dioxide and temperature on carbon partitioning, source- sink relations and respiration. *Plant Cell Environment* 14:819-830
7. FAO (2009). Seed Industry for food security in the light of climate change and soaring food prices challenges and opportunities
8. Hampton JG, Comer AJ, Boelt B, Chastain TG, Rolston (2016). Climate change: Seed production and option for adaption *Agriculture* 6:33
9. Hatfield JL, Boote KJ, Kimball BA, Ziska LH, Izaurrable RC (2011). Climate impacts on agriculture: Implications for crop production *Agronomy Journal* 103: 351-370
10. Idso SB, Kimball BA (1989). Growth response of carrot and radish to atmospheric CO_2 enrichment *Environmental and Experimental Botany* 29:135:139
11. Muabaa EL (1957). Effects of high temperature on incompatibility in radish. *Euphytica* 6: 268–27
12. Jaggard KW, Qi A, Ober ES (2010). Possible change to arable crop yield by 2050. *Philosphical Transactions of the Royal Biological Society* 365:2835-2851
13. Lamichaney A, Swain DK, Biswal P, Kumar V, Singh NP, Hazra KK (2019). Elevated atmospheric carbon–dioxide affects seed vigour of rice (Oryza sativa L.). *Environmental and Experimental Botany* 157:171–17
14. Lamichaney A, Maity A (2021). Implications of rising atmospheric carbon dioxide concentration on seed quality .*International Journal of Biometeorology* 65:805-812
15. Maity A, Vijay D, Mukhrjee A, Lamichaney A (2016). Potential impacts of climate change on quality seed production: A perspective of Hill Agriculture *Conservation agriculture* pp 459-485
16. Singh RP, Prasad PVV, Reddy KR (2013). Impacts of changing climate and climate variability on seed production and seed industry *Advances in Agronomy* 118:49-130
17. Powell AA (2006). Seed Vigor and its assement. In Handbook of Seed Science and Technology; Basra, AS Ed; Food production press: New York, NY, USA, 2006; PP 603-648
18. Saha S, Chakraborty D, Sehgal VK, Pal M (2015). Rising atmospheric CO2: potential impacts on chickpea seed quality. *Agriculture Ecosystem & Environment* 203:140–146
19. Quaderi MM, Reid DM (2005). Growth and physiological responses of canola to UV-B and CO_2 under controlled conditions. *Physiologia Plantrum* 125: 247-259
20. Ziska LH, Bunce JA (1997). Influence of increasing carbon dioxide concentration on the photosynthetic and growth stimulation of selected C4 crops and weeds *Photosynthesis Research* 54: 199-208
21. Zheng G, Chen J, Li W (2020) Impacts of CO2 elevation on the physiology and seed quality of soybean. *Plant Diversity* 42:44–5.