The increasing carbon dioxide (CO₂) due to global climate change strengthens the plants and inhibits pathogenic infection

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Climate change is a threatening global issue that has entirely changed the crops' growing pattern. The continuous change in climate has occurred due to dreadful human activities such as burning of fossil fuels (Batley and Edwards 2016), agricultural debris, plastic/polythene bags, and contaminated hospital syringes, surgical instruments, gloves etc. Similarly, emission of dangerous gases from factories, vehicles, and refrigerator is also polluting the environment and playing pivotal role to raise the temperature and consequently disturbing the climate (Thompson et al. 2017). Likewise, the emission of greenhouse gases (CO₂, CH₄ and N₂O) (IPCC 2007) has also increased the CO₂ concentration from 300 to 398 μmol mol⁻¹. According to the Inter-government Panel on Climate Change (IPCC-2013), the increase in CO₂ will ultimately enhance the air temperature from 0.3–1.7 °C during 2081–2100; whereas under high CO₂ emission, the predicted rise in temperature will be 2.6–4.8 °C (Thin et al. 2017). It is a matter of fact that the emission of dreadful gases is the major cause among other numerous factors of climate change (Tans and Keeling 2016).

Several new virulent races/ biotypes including PI-296341 of *Fusarium oxysporum* f. sp. *niveum*, *Plectosphaerella cucumerina* of Tomato wilt, and *Pseudomonas putida* of mustard rot of plant pathogens have appeared due to abrupt fluctuation in the environment. These virulent races/ biotypes under favorable growth conditions disrupt the planting density, cause huge losses in various crops, and resultantly diminish

the total production and yield. However, only carbon dioxide (CO₂) among these dangerous gases plays a significant role through stimulating biochemical and physiological defense in plants against diseases (Agrios 2005).

Carbon dioxide is the most imperative component of photosynthesis in plants. Thus, increase in CO₂ level directly enhances the rate of photosynthesis and consequently stimulates the plants vegetative growth, total biomass, leaves per plant, more photorespiration, carboxylation, and transpiration. The increase in photosynthesis is mainly due to increase in ribulose-1,5-bisphosphate (RuBP) carboxylase/oxygenase (Rubisco) activity (Makino and Mae 1999). RuBisCo, RuBPCase, or RuBPco is an enzyme that activates/initiate an imperative step of carbon fixation. Carbon fixation is a process in which plants and other photosynthetic organisms converts atmospheric carbon dioxide to energy-rich molecules such as glucose. The abundant availability of photosynthetic products (glucose as well as phosphoglyceraldehyde in C3 plants and oxaloacetate in C4 plants) also increases the rate of Kreb's or tricarboxylic acid cycle, transcription and translation, and production of protein molecules as well as availability of more ATPs (adenosine triphosphate). The increase in photosynthesis owing to CO₂ results in an increase in production and activation of phenolic compounds (chlorogenic acid, caffeic acid, and ferulic acid), manufacturing of more carbohydrates production such as glucose, sucrose, and fructose as well as alters nitrogen and carbon metabolism in plants (Garavaglia et al. 2010a, b).

Glucose stimulates different signaling enzymes such as hexokinase, SnRk1, and KIN10. Similarly, different other signaling molecules, i.e., salicylic acid, jasmonic acid, ethylene, and nitric oxide, are also induced in healthy plants after the attack of pathogen. The healthier plants retard hyphal growth and sporulation due to incompatibility in host pathogen interaction (Selvaraj and Bourlaye 2012). The minimum availability of CO₂ reduces the photosynthesis that causes necrosis and chlorosis. The plants become weak and vulnerable to aggressive virulent races of pathogens due to these physiological

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disorders and ultimately increase the pathogen invasion, infection, and disease appearance (Garavaglia et al. 2010a, b). Thus, it is concluded that climate change stimulates the rate of photosynthesis and strengthen the plants; healthier plants inhibit the pathogen invasion, penetration, and infection through signal transduction and activation of hypersensitive response as well as through physiological and biochemical defense.

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