Change in near-surface wind velocity: what implications will it have on ecosystem and agriculture?

Climate change deliberations are dominated by the trinity of the greenhouse gases (GHGs), temperature and rainfall, often sidelining the attention from all other weather parameters which may be influenced by the phenomenon and have quite a large impact on the environment in general and agriculture in particular. Near-surface wind velocity is one of the most important weather parameters which indirectly regulates the temperature, relative humidity and evaporative demand of the atmosphere. Though much focus has not been given to this crucial weather variable, it may influence the agricultural production system as a whole in this changing climatic scenario.

By and large the global studies[1] indicate the significant reduction in the near-surface wind velocity in most parts of the world, termed as 'stilling', also evident in India[2–4]. Scientists have attributed this phenomenon to have a major share in the reduction of the pan evaporation[1], indicator of 'global dimming'. The near-surface wind plays many crucial roles in maintaining the ecological processes. Wind creates continuous turbulence in the layer of the atmosphere close to the earth's surface, which indeed influences not only the plant physiological processes (photosynthesis, respiration, transpiration), but it also helps in spread of pollen, propagules and seeds. Turbulence generated through forced convection (caused by wind due to pressure gradient) determines the transfer of heat and mass in plant micro-environment, while free convection (diffusion) becomes important in case of very light wind condition[5,6]. As turbulent transfer tends to be 3–7 times faster than the diffusion[6], reduction of wind velocity may lessen the exchange rate of gases by decreasing the forced convection process. The reduced exchange rates may modify the heat and mass balance (mainly gases and water vapour) inside the canopy microclimate. The process of photosynthesis, respiration and transpiration, may be influenced by the changed balance of the gases. In the changing climatic scenario, though CO_2 enrichment of the atmosphere may boost the photosynthesis of C_3 plants, the decrease in the exchange rates may hinder the process, with all other factors remaining constant[7–9]. This may cut-off the rate of CO_2 supply from the atmosphere to the plant microclimate, particularly the microclimate in the individual vicinity of the leaves.

Wind primarily determines the aerodynamics of the atmosphere, which has a large influence on the reference evapotranspiration (ET), the main determinant of ET under water-sufficient conditions. As ET is known to have a direct relationship with the economic yield, its decrease due to wind may have a direct effect, particularly in the energy-limited zones[1]. With the decrease in wind velocity, rate of removal of moisture from the vicinity of the leaves may also slow down, creating vapour-saturated condition. This may directly influence both the crop ET and population build-up of pests and disease-causing organisms. The moisture-saturated atmosphere reduces the ET, if other factors are constant. The decrease in wind velocity may increase the aerodynamic resistance of the crop surface, thus reducing ET further. Many studies globally and in India have already reported the decrease in the potential evapotranspiration (PET)[4], which is in line with the discussion. With the increase in humidity, microclimate may become favourable for the germination and growth of fungal pathogen spores and other insect pests, which may enhance the burden on the crop and increase the risk of crop production. Anemophilous (pollination by wind) and ambophilous (mixed wind and animal pollination) plants largely depend upon the wind for their pollination. With the decrease in wind velocity, the pollen transfer efficiency of these processes may be severely reduced[10]. Furthermore, the decrease in the wind speed may result in this process failing to provide reproductive assurance for which it was evolved from animal pollination.

On the other hand, the reduction in wind velocity may be beneficial for the crops in the arid region where advection has a negative effect on the plants due to enhanced ET and also causes physical damage. The extent of soil erosion due to the wind factor may also decrease, which is quite common in the arid western and coastal regions of India. The movement of different pests, particularly locusts may be affected. It can also affect the transport of pathogen spores, particularly the rust cycles in India. Apart from these it will affect the transport of different pollution agents, which can have a direct effect on the human well-being. Hence, stilling should be considered for assessing the potential impact of changing climatic situation on environment and agriculture.

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DEBASISH CHAKRABORTY[1,*]
SAURAV SAHA[2]
R. K. SINGH[1]

[1]*Division of Agricultural Engineering, ICAR Research Complex for NEH Region, Umiam 793 103, India*
[2]*ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib 796 081, India*
**e-mail: debasishagri@gmail.com*