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The relationship between air pollution and crop yield

Wenzhi Zeng, Tao Ma, Guoqing Lei, Jingwei Wu, and Jiesheng Huang

State Key Laboratory of Water Resources and Hydropower Engineering Science, Wuhan University, Wuhan, China (zengwenzhi1989@whu.edu.cn)

Air pollution has been proved to affect human health. Meanwhile, crop growth characteristics also vary with climate factors such as radiation and temperature. However, the relationship between crop growth and air pollution is still unclear and one important limitation for solving this issue is the lack of air pollution data for both previous and future conditions. To find out the effects of air pollution on crop yields, data about weather, air pollution, and maize and winter wheat yields of 331 cities in China from 2014 to 2016 were collected and analyzed. Furthermore, Support Vector Regression (SVR) and World Food Studies (WOFOST) model were applied to extend the air pollution data of two typical cities (Beijing and Hetian) and further verify the relationship between air pollution and crop yield. More exactly, heavy air pollution usually happened in North China but smaller than moderate air pollution levels affected crop yields insignificantly. Moreover, both winter wheat and maize yields increased with moderate air pollution periods but decreased with heavy air pollution periods in 2014, 2015 and 2016. Importantly, there was a threshold value for the heavy air pollution periods to trigger the yield decrease. The threshold value of of maize in 2015 and 2016 were 7 days and 5 days respectively while of winter wheat were both 10 days in 2015 and 2016, respectively. Once the heavy air pollution periods became longer than the threshold value, both winter wheat and maize yields decreased linearly with the periods. Furthermore, the SVR was proved as a useful tool to mimic weather factors from air pollutants. Specifically, it accurately simulated all weather factors for Beijing and Hetian from 2014 to 2016 (R2>0.6) except the radiation and vapour pressure of Hetian in 2015. In addition, PM2.5 was the main air pollutant of Beijing in 2014 while PM2.5 and PM10 were the main air pollutants of Hetian in both 2015 and 2016, respectively. No matter the main air pollutant was PM2.5 or PM10, simulated potential winter wheat yields by WOFOST with moderate air pollution for whole growth periods were all higher than yields of observed and heavy air pollution conditions. However, under water stress, due to the coupling effects of water and air pollution, simulated winter wheat yield with heavy air pollution was even higher than the observed weather condition, indicating further study should focus on the mechanism of complex effects of different environmental stress factors on crop growth.