



## **Response of winter wheat phenology to climate change**

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Winter wheat is one of the main grain crops in China, so it is of great significance to discover the response of winter wheat phenology to climate change for dynamic monitoring of crop growth and field management. The Vegetation Index (VI) can accurately reflect the winter wheat phenology within a wide range of crop areas. This study examined the correlation and sensitivity between winter wheat phenology and accumulative climate variables in the North China Plain (NCP) over the period 2002–2016. The Normalized Difference Vegetation Index (NDVI) and Normalized Differential Phenology Index (NDPI) in period of 8 days multi-band Moderate Resolution Imaging Spectroradiometer (MODIS) data from 2002 to 2016 were used to extract the winter wheat phenology by using proportional threshold method. We set threshold range from 0% to 100% to extract key phenology like green-up date from overwintering stage to heading stage. In this study, the daily average temperature, daily average ground surface temperature and daily total precipitation of each meteorological station from 2002 to 2016 were used as climate variables. We calculated the accumulated climatic factors for a period of time before the phenology as an independent variable. The accumulative period was varied from 30 days to 90 days. The result showed: 1) the early and late period of spring phenology are most sensitive to climate change, which refers to growth resume date and heading date. 2) In the north, the most sensitive period appeared at early period of spring phenology. In contrast, in the south, it appeared at late period of spring phenology.