

Exploring the Spatial-temporal Coupling Pattern of Grain Yield and Fertilization from Historical Practice for Better Future Application: A Case in the North China Plain

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Fertilization, especially the application of chemical fertilizer, is one of the important measures to promote grain yield. However, the increasing input of chemical fertilizer has led to a variety of pollutions, such as soil pollution and water pollution, which has a serious negative impact on the ecological environment. Therefore, the scientific application of chemical fertilizer plays a vital role in both increasing grain yield and maintaining the ecological environment. This brings an urgent scientific problem, that is, how to find the clue of rational fertilization from the coupling pattern between fertilization and grain yield to guide the future fertilization strategy. However, previous studies rarely focus on the spatial-temporal coupling pattern of grain yield and fertilization from the perspective of large-scale and long-term. In other words, how to find the spatial-temporal coupling pattern between grain yield and fertilization on the large-scale and long-term, so as to provide scientific support for rational and effective fertilization, the relevant research is still lacking. In this study, an analytical method for analyzing the spatial-temporal coupling pattern of grain yield-fertilization based on large-area, long-term serial grain yield, and fertilization data were constructed. Taking the North China Plain as an example, the spatial-temporal coupling pattern, regional differentiation rule and dynamic evolution trend of grain yield and fertilization during 1990-2015 were revealed by using this method. The results show that: (1) the overall grain production in the North China Plain maintained a steady growth trend, while the fertilization intensity increased and then decreased. The coupling pattern between them showed characteristics of non-stationarity in time and space. At the same time, with the increased fertilizer application, its contribution to the increase of grain yield decreased. (2) Different types of food crops responded differently to different types of chemical fertilizers. Among them, the effect of nitrogen fertilizer on increasing yield of rice and wheat was far greater than that of phosphate fertilizer and potassium fertilizer. Since 2010, the effect of fertilization intensity on maize yield has become more and more clearly coupled in time and space, but not before. (3) The effect of the double fertilizers on grain yield was better than a single fertilizer. It is suggested that in the future, it is necessary to comprehensively consider fertilization strategies such as improving the utilization rate of chemical fertilizer, applying fertilizer according to local conditions and applying multiple fertilizers together, so as to achieve better yield increasing effect.

Keywords: grain yield and fertilization, spatial-temporal coupling pattern, geographically weighted regression, geographic detector, the North China Plain