Using an Integrated Response-Function Method to Explore Agro-Climatic Suitability for Spring Soybean Growth in North China

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ABSTRACT

To understand agro-climatic suitability for spring soybean growth in north China, an integrated crop-response-function method was developed. This method includes crop-response functions for temperature, precipitation, and sunshine and is assessed by a weighting method based on the coefficient of determination. The results show that the most suitable area (S1) for spring soybean growth occupied approximately 21.35% of the total area of north China. Among three types of spring soybeans of early maturity, middle maturity, and late maturity, middle maturity was the most suitable variety to grow in the study area, covering nearly 1.133×10^6 km^2 or about 99.75% of the total area of S1. As a result of this study, the authors suggest that breeders pay more attention to middle-maturity cultivars in north China. The findings from this study may provide useful information for policy makers issuing guidelines for agricultural production.

1. Introduction

China is the fourth major soybean producer in the world after United States, Brazil, and Argentina. In the recent 30 years, the total production of soybean has been steadily increasing to reach approximately 16 million tons. Spring soybeans, which are an important crop in north China, account for more than two-thirds of the total area and quantity of soybeans grown across the nation (Kou and Feng 2008, 4–6).

Until now, published research on the effects of climatic factors on soybeans concentrated on the response of soybean growth and final yield to climatic factors (Sinclair and Rawlins 1993; Lal et al. 1999; Bhatia et al. 2008). However, to guide agricultural production, some countries have introduced agro-climatic crop regionalization aiming at avoiding low-efficiency crops cultivation (Brown and Chapman 1960a,b, 1961; Nuttonson 1965; Li 1987). The regionalization was based on identification of agro-climatic suitability (Ogunkun 1993; Satyavathi and Reddy 2004; Yang et al. 2010). Some studies related to agro-climatic suitability for crops, especially for soybeans, showed methods based on analysis of data for the whole life cycles of crops. Since crop growth and yield are largely determined by weather during the growing season, even minor deviations from the usual weather pattern in any growing phase will lead to a reduction in the efficiency of externally applied inputs and thus to yield reduction (Mall et al. 2004). In addition, response functions of single climatic factor developed for detecting crop agro-climatic suitability need to be integrated (Cutforth and Shaykewich 1990; Zhao et al. 2003; Wei et al. 2007).

In light of the increasing concerns, this study seeks to achieve three objectives: 1) to develop an integrated crop-response-function method to evaluate agro-climatic suitability for spring soybean growth in north China; 2) to map agro-climatic suitability for spring soybean growth at a large geographic scale; 3) to provide the methodological basis for future study on the effect of climate change on agro-climatic suitability for spring soybeans.

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