

RESEARCH ARTICLE

Basic Soil Productivity of Spring Maize in Black Soil Under Long-Term Fertilization Based on DSSAT Model

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Abstract

Increasing basic farmland soil productivity has significance in reducing fertilizer application and maintaining high yield of crops. In this study, we defined that the basic soil productivity (BSP) is the production capacity of a farmland soil with its own physical and chemical properties for a specific crop season under local environment and field management. Based on 22-yr (1990-2011) long-term experimental data on black soil (*Typic hapludoll*) in Gongzhuling, Jilin Province, Northeast China, the decision support system for an agro-technology transfer (DSSAT)-CERES-Maize model was applied to simulate the yield by BSP of spring maize (*Zea mays* L.) to examine the effects of long-term fertilization on changes of BSP and explore the mechanisms of BSP increasing. Five treatments were examined: (1) no-fertilization control (control); (2) chemical nitrogen, phosphorus, and potassium (NPK); (3) NPK plus farmyard manure (NPKM); (4) 1.5 time of NPKM (1.5NPKM) and (5) NPK plus straw (NPKS). Results showed that after 22-yr fertilization, the yield by BSP of spring maize significantly increased 78.0, 101.2, and 69.4% under the NPKM, 1.5NPKM and NPKS, respectively, compared to the initial value (in 1992), but not significant under NPK (26.9% increase) and the control (8.9% decrease). The contribution percentage of BSP showed a significant rising trend ($P<0.05$) under 1.5NPKM. The average contribution percentage of BSP among fertilizations ranged from 74.4 to 84.7%, and ranked as 1.5NPKM>NPKM>NPK≈NPKS, indicating that organic manure combined with chemical fertilizers (1.5NPKM and NPKM) could more effectively increase BSP compared with the inorganic fertilizer application alone (NPK) in the black soil. This study showed that soil organic matter (SOM) was the key factor among various fertility factors that could affect BSP in the black soil, and total N, total P and/or available P also played important role in BSP increasing. Compared with the chemical fertilization, a balanced chemical plus manure or straw fertilization (NPKM or NPKS) not only increased the concentrations of soil nutrient, but also improved the soil physical properties, and structure and diversity of soil microbial population, resulting in an increase of BSP. We recommend that a balanced chemical plus manure or straw fertilization (NPKM or NPKS) should be the fertilization practices to enhance spring maize yield and improve BSP in the black soil of Northeast China.

Key words: spring maize, long-term fertilization, basic soil productivity, black soil, DSSAT model

INTRODUCTION

With a cropping area of 7.4 million ha and a population

over 109.3 millions, the black soil (*Typic hapludoll*) region of northeastern China plays a crucial role in food security to the regional and whole country. However, the long-term intensive maize

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