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Response of Grain Yield to Climate Change in Shaanxi Province

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Abstract

The objective is studying characteristics of climate change in Shaanxi Province and its impact on grain yield. Based on the meteorological data and grain yield data of Shaanxi Province from 1980 to 2016, this paper studied the characteristics of climate change(precipitation, temperature, sunshine hours) and their impact on yields of three major grain crops in Shaanxi over the past 37 years. The gray correlation method was used to analyze the relationship between climate change and yield of three major grain crops. In the annual and seasonal climatic factors, wheat and corn yields were most affected by the average spring temperature and soybean yields were most affected by autumn precipitation. The climatic yields of wheat were most affected by summer sunshine hours, while the climatic yields of corn and soybeans were most affected by summer precipitation.

Keywords

Shaanxi Province; Climate Change; Grain Yields; Gray Correlation Analysis.

1. Introduction

Food crops have a strong dependence on climate resources and are extremely sensitive to climate change[1]. In the context of global warming, the temporal and spatial distribution patterns of climate resources have changed, and the impact of climate change on agricultural production has become the focus of attention of scholars at home and abroad[2-3]. Existing studies have shown that climate warming may lead to faster growth of food crops, resulting in a shorter growth process of crops, thereby affecting crop yields[4]. In addition, climate change can affect agricultural production through extreme weather events, changing the development process of food crops, and changing the distribution pattern of suitable crop growing areas[5]. Significant changes in climate resources will inevitably have various impacts on Shaanxi's agricultural production and ecological environment. Therefore, understanding the impact of climate change on food production is the key to Shaanxi Province's optimization of food production policies and a better response to future climate changes.

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2. Data and Research Method

2.1. Data

Using data from 16 national meteorological stations in Shaanxi Province from 1980 to 2016, such as temperature, precipitation and sunshine hours, and the change characteristics of the time series of various climatic elements were analyzed month by month. Select the total grain output of wheat, corn, and soybean in Shaanxi Province from 1961 to 2016, and analyzed the change characteristics of the yield per unit area of the three main grain crops. The data comes from the National Bureau of Statistics.

2.2. Research Method

In this paper, the dispersion standardization method was used to normalize the yield data series of the three main food crops, and MATLAB software was used to calculate the gray correlation degree of the relationship between the climatic yield of the main food crops and different climatic elements.

3. Results and Analysis

According to the grey relational analysis method, with the grain output of three crops in Shaanxi Province from 1980 to 2016 as a reference, the grey relational degree of the three crops with annual and seasonal precipitation, average temperature and sunshine hours were calculated in Table 1. It can be seen from table 1 that the unit yield and climate yield of three main grain crops in Shaanxi Province have a good correlation with climate factors in recent 37 years, and the correlation degree is between 0.622 ~ 0.759. The correlation between wheat yield and spring average temperature was the largest, with a correlation degree of 0.731, followed by annual average temperature, autumn average temperature and summer average temperature, with correlation degrees of 0.723, 0.720, and 0.707 respectively. These results indicated that the yield of wheat per unit area was most affected by the average temperature in spring, which was the main environmental factor that determines the yield of wheat per unit area. The correlation between wheat yield and precipitation at annual and seasonal scales was relatively small, indicating that wheat yield was relatively less affected by precipitation. Wheat climatic yield had the greatest correlation with summer sunshine hours, with a correlation degree of 0.736, followed by autumn sunshine hours, annual precipitation, and autumn precipitation, with correlation degrees of 0.735, 0.730, and 0.719, respectively, indicating that wheat climate yield was affected by the weather. Summer and autumn sunshine hours had a greater impact, followed by precipitation on the climate yield of wheat. The correlation degree between wheat climatic yield and the sunshine hours in spring is the smallest, with a correlation degree of 0.660.

The order of the correlation degree between corn yield and various climatic elements was basically consistent with that of wheat(Table 1). The average temperature in spring and annual average temperature had the greatest impact on corn yield, and the correlation degree was 0.745. The correlation degree between corn yield and autumn precipitation was the smallest, and the correlation degree is 0.647. These results showed that the per unit yield of maize was also greatly affected by temperature and less affected by precipitation. The climatic yield of corn had the largest correlation with summer precipitation, with a correlation of 0.759, followed by annual precipitation, spring precipitation, and autumn average temperature, with correlations of 0.748, 0.740, and 0.737, respectively. The correlation degree between maize climate yield and summer precipitation was the largest, with the correlation degree of 0.759, followed by annual precipitation, spring precipitation and autumn average temperature, with the correlation degrees of 0.748, 0.740 and 0.737 respectively. The grey correlation degree between maize climate yield and sunshine hours in spring was the smallest, with the correlation degree of 0.627, followed by spring average temperature and annual average temperature, with the correlation degrees of 0.649 and 0.667 respectively.

The correlation degree between soybean yield and autumn precipitation was the largest, with the correlation degree of 0.724, followed by annual precipitation, winter precipitation and summer precipitation, with the correlation degrees of 0.722, 0.716 and 0.691 respectively, indicating that precipitation had a great impact on soybean yield(Table 1). The correlation between soybean yield and sunshine hours was relatively small, indicating that sunshine hours had a relatively small impact on soybean yield. The correlation degree between soybean climate yield and summer precipitation was the largest, with the correlation degree of 0.734, followed by annual precipitation, winter sunshine hours and autumn sunshine hours, with the correlation degrees of 0.726, 0.716 and 0.707 respectively.

Table 1. Correlation between grain yield and climate factors in Shaanxi Province from 1980 to 2016

Climatic factors	Wheat yield per unit area	Corn yield per unit area	Soybean yield per unit area	Climatic yield of wheat	Climatic yield of corn	Climatic yield of soybean
Annual precipitation	0.663	0.652	0.722	0.730	0.748	0.726
Spring precipitation	0.623	0.660	0.685	0.699	0.740	0.698
Summer precipitation	0.671	0.657	0.691	0.716	0.759	0.734
Autumn precipitation	0.632	0.647	0.724	0.719	0.693	0.666
Winter precipitation	0.656	0.670	0.716	0.696	0.701	0.672
Annual average temperature	0.723	0.745	0.651	0.686	0.667	0.638
Spring average temperature	0.731	0.745	0.681	0.695	0.649	0.653
Summer average temperature	0.707	0.708	0.682	0.710	0.716	0.642
Autumn average temperature	0.720	0.735	0.678	0.698	0.737	0.696
Winter average temperature	0.699	0.687	0.689	0.685	0.670	0.662
Annual sunshine hours	0.693	0.695	0.622	0.715	0.694	0.658
Spring sunshine hours	0.645	0.655	0.674	0.660	0.627	0.628
Summer sunshine hours	0.669	0.660	0.634	0.736	0.689	0.655
Autumn sunshine hours	0.697	0.673	0.625	0.735	0.735	0.707
Winter sunshine hours	0.686	0.703	0.646	0.700	0.727	0.716

4. Conclusion

Both wheat yield and corn yield in Shaanxi Province were greatly affected by temperature. The correlations between average spring temperature and wheat yield and corn yield were 0.731 and 0.745, respectively, which were the largest in their respective rankings. Soybean yield was greatly affected by precipitation, which had the greatest correlation with autumn precipitation, with a correlation degree of 0.724. The climatic yield of corn and the climatic yield of soybeans and summer precipitation were the largest in their respective rankings of correlation degrees,

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with correlation degrees of 0.759 and 0.734, respectively. The increase in summer rainfall was conducive to the increase in climatic yields of corn and soybeans.

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