Climate Response of Water Requirement Variation During Cotton Growth Period in Tacheng Region: Postprint

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Abstract

To investigate the changing trends of cotton water requirements during the growth period in the Tacheng region and study their relationship with meteorological factors, thereby providing a theoretical basis and scientific foundation for cotton irrigation and drainage under climate change impacts. Using integrated calculations of daily temperature, precipitation, sunshine hours, wind speed, relative humidity, and other data from 1961 to 2013 in the Tacheng region, the water requirements and irrigation water requirements of cotton in the Tacheng region over the past 53 a were calculated, and their response to climate change was explored. The results show: Over the past 53 a, cotton water requirements in the Tacheng region exhibited an overall decreasing trend, with a particularly significant reduction during the flowering and boll-forming stage (climatic tendency rate of -1.51 mm • (10a) ^{1}); cotton water requirements during the flowering and boll-forming stage were 103.96 mm, higher than those of other growth stages. Cotton irrigation water requirements also showed an overall decreasing trend, with the irrigation water requirements during the flowering and boll-forming stage being the highest (mean value of 77.79 mm) and exhibiting the most significant decreasing trend (climatic tendency rate of -2.90 mm • (10a) ^{1}, $P<0.01$). Strong correlations exist between meteorological factors and both crop water requirements and irrigation water requirements during various cotton growth stages; among meteorological factors, precipitation exerts the greatest influence on cotton irrigation water requirements.

Full Text

Preamble

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1 Introduction

The cotton growing season was divided into distinct growth stages with corresponding crop coefficients (Kc): - Initial stage: May 1–June 19, Kc = 0.25 - Development stage: June 20–July 15, Kc = 0.47 - Mid-season stage: July 16–August 11, Kc = 1.76 - Late-season stage: August 12–September 30, Kc = 0.14 - Entire growth period: May 1–September 30, Kc = 0.55

2 Methods

2.1 Calculation of Crop Water Demand

The FAO Penman-Monteith method was used to calculate reference evapotranspiration (ET) 〔13〕 . Crop water demand (ETc) was then computed using the crop coefficient approach 〔14〕 :

$$ETc = ET_0 \times K_c$$

where ET is reference evapotranspiration (mm) and Kc is the crop coefficient 〔15〕 .

2.2 Data Collection

Meteorological data from 1961 to 2013, including daily air temperature, precipitation, sunshine duration, wind speed, and relative humidity, were used to calculate cotton water demand and irrigation water volume for the study area.

3 Results

3.1 Trends in Water Demand and Irrigation Volume

[Figure 2: see original paper] shows the variation in cotton water demand across different growing seasons. [Figure 3: see original paper] illustrates the changes in irrigation water volume for cotton.

3.2 Climate Factor Trends

presents the trends of climatic factors during different cotton growing seasons. The analysis reveals changes in temperature, sunshine hours, vapor pressure, wind speed, and relative humidity across growth stages.

3.3 Correlation Analysis

and quantify the relationships between water demand, irrigation volume, and meteorological factors. Precipitation demonstrated the strongest correlation with both crop water demand and irrigation requirements, particularly during the flowering and boll-setting stage, where the correlation coefficient between precipitation and irrigation volume reached -0.987 ($P < 0.01$).

Key findings include: 1. Cotton water demand in Tachang Prefecture decreased over the 53-year study period, especially during the flowering and boll-setting stage, with a climate tendency rate of -1.51 mm $\cdot$ (10a) ^{1}. 2. Water demand peaked during the flowering and boll-setting stage, averaging 103.96 mm. 3. Irrigation water volume also declined, with the most significant reduction occurring during the flowering and boll-setting stage (climate tendency rate: -2.90 mm $\cdot$ (10a) ^{1}, $P < 0.01$), where the average irrigation volume was 77.79 mm.

4 Discussion

Over the 53-year period from 1961 to 2013, both cotton water demand and irrigation water volume in Tachang Prefecture showed significant decreasing trends, particularly during the critical flowering and boll-setting stage. These trends are closely associated with regional climate change, with precipitation identified as the most influential meteorological factor 〔17-19〕 .

The findings align with previous research on climate change impacts on agricultural water requirements in Northwest China. The observed changes have important implications for irrigation scheduling and water resource management, highlighting the need for adaptive strategies to enhance water use efficiency under evolving climatic conditions.

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Abstract: In this study, the relationship between the change trend of water demand of cotton plant and the meteorological factors was lucubrated so as to explore the change trend of water demand of cotton plant in different growing seasons in Tachang Prefecture. The purpose of the study was to provide the theoretical and scientific bases for the irrigation and drainage of cotton field under climate change. The data of daily air temperature, precipitation, sunshine duration, wind speed, relative humidity, etc. during the period from 1961 to 2013 were used to calculate the water demand and irrigation water volume of cotton plant in the study area in recent 53 years, and to explore its response to climate change. The results showed that: In recent 53 years, the water demand of cotton plant in Tachang was generally decreased, particularly at the flowering and boll-setting stage. The climate tendency rate was -1.51 mm · (10a) ^{1}; the water demand of cotton plant was 103.96 mm at the flowering and boll-setting stage and higher than that in other growing seasons: Irrigation water volume of cotton plant was generally in a decrease trend, in which it

was the highest at the flowering and boll-setting stage, its average volume was 77.79 mm, and its reduction at the flowering and boll-setting stage was the most obvious (the climatic tendency rate was -2.90 mm · (10a) ^{1}, $P < 0.01$); There was a high correlation between meteorological factors and the crop water demand and irrigation water volume in all the cotton growing seasons. Among the meteorological factors, the effect of precipitation was the most significant.

Keywords: crop water demand; irrigation water volume; climatic factor; cotton; Tachang Prefecture

Note: Figure translations are in progress. See original paper for figures.