Analysis of historic rainfall characteristics for robust wheat cropping in North Anhui

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Abstract

Northern part of Anhui is one of major wheat producing areas in China. The total amount of rainfall is sufficient for wheat season; however, it is unevenly distributed at the different growth stages, resulting in risk of yield losses. In order to optimise the cultivation in North Anhui, it is essential to characterise the rainfall pattern for wheat growth particularly in the critical period (i.e. the months of sowing and harvesting). By analysing the rainfall data from 1955 to 2017, this study characterised the rainfall pattern from six sites representing different regions of North Anhui. The frequency of continuous rainfall days during sowing and harvesting periods were quantified based on 63 years rainfall distribution. The characterisation of rainfall in six representative sites in North Anhui were able to be used to guide wheat sowing and harvesting, which could help farmers to make decisions and avoid likelihood of cropping risks.

Key Words

Winter wheat, rainfall pattern, sustainable cropping, China

Introduction

Huang-Huai-Hai plain is a major wheat production area in China (Yang, 2018). The northern part of Anhui province belongs to south Huang-Huai-Hai plain. The wheat sowing time normally varies 1 week before or after October 15 and harvesting is tightly closing to May 31 in the following year. The climate characteristics particularly rainfall distribution over the season are complicated in North Anhui as it is in the transitional zone between the North and South China. However, the climate data in this region has not been analysed quantitatively. The accumulation and analysis of considerable climatic data can provide more accurate and valuable information for the study of wheat cultivation (Tao et al., 2006). The mechanisation of sowing and harvesting is strongly subjected to rainfall. In addition, undesirable heavy rainfall causes the sowing delay, culm lodging and grain sprouting prior to harvesting. It is reported that winter wheat seedling emergence was delayed and whole growth period shortened due to uneven distribution of rainfall over the growing season (Li et al. 2013). Daily climate data from 1955 to 2017 of six weather stations in North Anhui were used in this study. We aimed to characterise the rainfall occurrence over 63 years across six sites and analyse disaster likelihood associated with rainfall events.

2.Methods

2.1. Data source

The climate data over 63 years (1955-2017) from six weather stations were used in the analysis. They were from Bengbu (East), Shouxian (South), Fuyang (West), Dangshan (North), Suzhou (East North), and Bozhou (West North) weather stations representing the whole Huaibei plain region. Six sites in North Anhui belong to the main wheat-growing areas. The wheat sowing occurs normally 1 week before or after October 15 and harvesting is around May 30 in the following year. The period of gibberellic disease occurrence is from April 17 to May 21. In this paper, the rainfall was divided into four intervals, i.e. greater or equal to 90 mm, 90-60 mm, 60-30 mm and less than 30 mm.

2.2. Data analysis

In this study, we mainly analysed the seasonal rainfall characteristics in the six sites. The 63 years rainfall data over the wheat growing seas continuous on from six sites were analysed.

3. Results

3.1 Seasonal rainfall characteristics overtime

The rainfall characteristics including average rainfall, maximum rainfall, and the proportion of monthly rainfall in May and October over 63 years across six representative sites in North Anhui are shown in Table 1. The average rainfall over 63 years was 50.32 mm (Bengbu), 54.21 mm (Shouxian), 46.20 mm (Bozhou), 53.59 mm (Fuyang), 38.1 mm (Dangshan), and 47.37 mm (Suzhou) at the sowing month (see Table 1). The maximum rainfall was 230.1 mm (Bengbu), 234.7 mm (Shouxian), 187.6 mm (Bozhou), 245.6 mm (Fuyang), 119.0 mm (Dangshan), 256.5 mm (Suzhou). The proportion rainfall of sowing month accounting for the whole wheat season ranges from 13.94% (Bengbu) to 16.57% (Bozhou). At the harvesting month, the average rainfall over 63 years was 75.96 mm (Bengbu), 78.13 mm (Shouxian), 68.34 mm (Bozhou), 83.81mm (Fuyang), 65.16 mm (Dangshan), 65.16 mm (Suzhou) respectively (Table 1). The maximum rainfall was 189.9 mm (Bengbu), 181.1 mm (Shouxian), 300.8 mm (Bozhou), 234.2 mm (Fuyang), 242 mm (Dangshan), and 244.5 mm (Suzhou). The rainfall during harvesting month accounting for whole wheat season fluctuated from 20.67% to 24.71%. According to data analysis, the average rainfall in October was less than that in May.

Table 1. The rainfall characteristics in sowing and havesting over 63 years in North Anhui

	Bengbu		Shouxian		Bozhou		Fuyang		Dangshan		Suzhou	
	SM	HM	SM	HM	SM	HM	SM	HM	SM	HM	SM	HM
AR (mm)	50.3	76.0	54.2	78.1	46.2	68.3	53.6	83.8	38.1	65.2	47.4	65.2
MR (mm)	230.1	190.0	234.7	180.1	187.6	300.8	245.6	234.2	119.0	242.0	256.5	244.5
FQ (%)	14.0	21.0	14.3	20.7	16.6	24.5	14.7	23.0	15.5	24.7	15.8	21.7

SM indicates sowing month; HM indicates harvesting month; AR indicates average rainfall; MR indicates maximum rainfall; FQ indicates frequency

3.2 The frequency of rainfall rank overtime

Table 2 lists the frequency of different rainfall rank in sowing month and harvesting month over 63 years across six representative sites in North Anhui. The rainfall during wheat sowing period is mainly below 60 mm in Bengbu, Fuyang, Dangshan, Suzhou, however, in Shouxian and Bozhou an over 30% probability of rainfall greater than 60 mm during the sowing period. During the wheat sowing period, the proper amount of rainfall is beneficial to the completion of sowing, and too much rainfall will cause the delay of sowing time. It is reported that the delay in sowing time results in the reduction of wheat yield compared to the optimal time (Ali et al., 2010). The higher frequency of rainfall was distributed at Bengbu, Shouxian, and Fuyang in harvesting month. The frequency of rainfall ranges from 20.60% (Bozhou) to 41.30% (Fuyang) when the rainfall is more than 90mm. In harvesting month, the rainfall affects wheat grain-filling, and also causes Fusarium head blight (FHB). Due to the lack of data on the combination of production and rainfall, the production guidance for wheat needs to be further investigated. The grouping of rainfall data provides more details in advising sowing and harvesting.

Table 2. The probability of different rainfall ranks in sowing and havesting over 63 years in North Anhui (%)

Rainfall	Bengbu		Shouxian		Bozhou		Fuyang		Dangshan		Suzhou	
(mm)	SM	HM	SM	HM	SM	HM	SM	HM	SM	HM	SM	HM
<30	42.9	15.9	34.9	12.7	47.6	31.7	41.3	11.1	52.4	33.3	47.6	23.8
30-60	30.1	28.5	33.3	33.3	22.2	30.2	30.2	22.2	25.4	28.6	23.8	33.3
60-90	7.9	17.5	12.7	19	11.1	17.5	6.3	25.4	12.7	12.7	15.9	20.6
⩾90	19.1	38.1	19.1	34.9	19.1	20.6	22.2	41.3	9.5	25.4	12.7	22.2

SM indicates sowing month; HM indicates harvesting month

Conclusions

This paper analysed the rainfall characteristics in May (harvesting month) and October (sowing month) from 6 sites representing North Anhui. It was similar among the six sites though there was slight difference. Average rainfall in May appears greater than in October. The rainfall frequency greater than 90 mm was relatively high, which causes risk of wheat cropping The combinations of the rainfall pattern and the characteristics of winter wheat growth and development were able to help find solutions to cope with undesirable rainfall. Thus these findings are of great significance in guiding winter wheat sowing and harvesting, and thus ensuring stable wheat productivity.

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