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To cite this article: Ruiqing Zhang et al 2018 IOP Conf. Ser.: Earth Environ. Sci. 170 032163

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Change Characteristics of Soil Moisture Content Under Different Planting Patterns

Ruiqing Zhang¹, 2, 3, 4, Kun Shu¹, *, Zenghui Sun¹, 2, 3, 4

¹Shaanxi Provincial Land Engineering Construction Group Co., Ltd, Xi'an 710075, China
²Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd, Xi'an 710075, China
³Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Land and Resources, Xi'an 710075, China
⁴Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Xi'an 710075, China

*Corresponding author e-mail: 78666975@qq.com

Abstract. In order to clarify the changes in the soil moisture content in different soil layers under different planting patterns, by using the field experiment, the change characteristics of soil moisture content under the treatment of 3 kinds of planting patterns of winter wheat-summer maize (T0), season spring maize (T1) and herbage-spring maize (T2) are analyzed from 2010 to 2011. The results show that the change range of the soil moisture content varies in different soil layers under different planting patterns and the moisture contents of T0, T1 and T2 treatment are the highest in 90-105cm, which are 0.28 m³·m⁻³, 0.44 m³·m⁻³ and 0.44 m³·m⁻³ respectively. Before sowing the spring maize for different planting patterns, T0 and T2 planting patterns decreased with the increase of time and the T1 planting pattern changed little with the increase of time. However, while in the growing season of maize, the soil moisture content of T0, T1 and T2 planting patterns has the consistent trend with the change of time.

1. Introduction

Agriculture, as a major consumer of water in China, has 400 billion m³ of annual water consumption, which accounts for about 70% of the total water consumption in China [1]. The average per capita in China's water resources is 2250 m³, which accounts for only 1/4 [2] of the average world level. Some researchers pointed out that in the North China Plain, the main planting pattern of crops is the winter wheat-summer maize rotation system, but the rainfall in this area cannot meet the water requirement of double-crop rotation products each year, and there is a severe deficiency in the growth Stages for winter wheat [3-5]. At present, the agricultural production maintains at the expense of overexploitation of groundwater resources stored in the past years, and if we do not take effective measures, the shallow groundwater will encounter the danger of exhaustion, which will lead to the unsustainable development of agriculture. In view of the above problems, we have confirmed for many years that to a certain extent, the reduced irrigation for the winter wheat cannot achieve the exploitation and supply...
balance of groundwater resources, and in the long term, we should reduce the planting area of winter wheat to increase the proportion of low water consumption crops [6-7]. The test makes clear moisture changes of different planting patterns by comparing the change characteristics of soil moisture content in different soil layers under the three patterns, such as winter wheat-summer maize planting pattern, herbage-spring maize planting pattern and season spring maize planting model. It provides a theoretical basis for the sustainable development of water resources and the planting patterns of food security in the North China Plain.

2. Organization of the Text

2.1. General situation of research areas
Located at the Shangzhuang experimental station of China Agricultural University, found in September 2004, the test is located at 116°11’ E and 40°8’ N in Xinlitun Village, Shangzhuang Town, Northwestern Haidian District, Beijing with 50m attitude. Its landform belongs to the North China alluvial plain, its main soil type is alluvial soil, and its soil texture is sandy loam.

2.2. Test design
The total area of the test area is 45 m×60 m, and the test plot area is 16 m×13 m. According to crop planting patterns in agricultural production, we divide the test into 3 treatments, which are as follows:

(1) Under the traditional planting pattern of winter wheat-summer maize (T0), on October 6, 2010, we sowed the winter wheat in the test plot and planted the summer maize after the harvest on June 2, 2011.

(2) Under the planting pattern of season spring maize (T1), on October 5, 2010, we smashed the summer maize stalk to cover the soil surface, and planed the spring maize on May 15, 2011.

(3) Under the planting pattern of herbage-spring maize (T2), we sowed herbages (triticale) on October 6, 2010, turned herbages into soil as green manure on May 14, 2011 and planted spring maize on May 15, 2011.

2.3. Crop variety and field management
Winter wheat variety is Nongda 211, summer maize 335, spring maize Zhuodan 10, and gramineous forage grass triticale is a new winter and spring feed crop.

Before sowing wheat and herbage, we smash the maize stalk to cover the soil surface in the soil corresponding to test plots, sow seeds by using human ridging machines. With 30cm of furrow width, 300 kg/hm² of sowing amount and 20cm of row spacing, we sow two rows in each ditch at the edge of the ridge. We carry out the test in the field under adequate water supply and adopt the flood irrigation, and we carry out fertilization and field management according to local customs.

For maize planting treatment, spring and summer maize uses ridge planting with 20 ridges in each district, 70 cm of ridge width, 16m of ridge length, 60000 plants/hm² of sowing amount, 50cm of row spacing and 15cm of row spacing.

Field management of test crops includes irrigation (irrigation time and irrigation amount), top application (fertilization time and fertilization amount), weed control, harvest (harvest time and yield), all of which are carried out in the local routine. Summer maize fertilization and irrigation method: field management of summer maize is consistent with that of spring maize.

2.4. Determination method of soil moisture content
We embed three tubes in each treatment and measure them every 5 days. Before and after obvious rainfall, we need to add a measurement once; the instrument used is TRIME-PICO IPH/T3.

In this paper, the test data use Excel2003 to carry out analysis and use Sigma Plot 10.0 for plotting. During the analysis, the mean value is compared with the significant difference method SARS, and the significant level between treatments is p<0.05.
3. Organization of the Text

3.1. Characteristics of soil moisture content with the change of time in the 10-15cm soil layer
As shown in Fig. 1, soil moisture content at 0cm ~15 cm shows the change of wave trend with time due to the rainfall, irrigation and crop. During the whole crop growth season, the fluctuation range of surface water content of T0 and T2 treatments ranges from 0.08 m$^3$·m$^{-3}$ to 0.24m$^3$·m$^{-3}$, while the fluctuation range of surface water content of T1 treatment is from 0.12 m$^3$·m$^{-3}$ to 0.24m$^3$·m$^{-3}$. Before sowing spring maize on May 15, 2011, the soil moisture content of T0 and T2 treatments shows the decreasing trend with time, while in T1 treatment, the soil moisture content at 0cm ~15cm changes steadily with time, because winter wheat-pasture are planted in T0 and T2 treatments. During the period of rapid growth and development of crops, it consumes a lot of water, while during the period, with scarce rainfall, crops can only get the water needed from the soil, which leads to the emergence of water difference. After the summer maize planting in June 23, in the future growth of maize, the rainfall mainly affects the soil moisture content at 0cm ~15cm with sufficient rainfall, and the fluctuation trend is consistent.

![Graphs showing soil moisture content changes in different districts.](image)

Fig. 1 Soil moisture content in the 0cm ~ 15cm soil layer measured in each district.

3.2. Change characteristics of soil moisture content with time in the 245-60cm soil layer
As shown in Figure 2, the soil moisture content at 45~60 cm in T0 and T2 treatments shows the trend of decreasing water content in the middle of May before sowing spring maize, and with the impact of irrigation water, the water content of T0 treatment varies between 0.12 m$^3$·m$^{-3}$ and 0.27 m$^3$·m$^{-3}$. However, without irrigation during this period, the water content of T2 treatment varies between 0.16 m$^3$·m$^{-3}$ and 0.24 m$^3$·m$^{-3}$, and with a relatively gentle general trend of change of soil moisture content at 45~60 cm, the water content of T1 treatment varies between 0.16 m$^3$·m$^{-3}$ and 0.25 m$^3$·m$^{-3}$. 0cm~60 cm is the main range of plant root activities, and during this period, the difference of water content is mainly due to water consumption of crop growth. During the harvest period after planting summer maize, the rainfall mainly affects the change of water content, so its trend of change is the same in general and the water content increases first and then decreases with time. The water content of T1 and
T2 treatments reaches about 0.35 m$^3$·m$^-3$ during this period, while the water content of T0 treatment reaches about 0.30 m$^3$·m$^-3$.

![Graphs showing soil moisture content changes](image1)

Fig. 2 Soil moisture content in the 45~60cm soil layer measured in each district.

3.3. Change characteristics of soil moisture content with time in the 90~105cm soil layer

As shown in Figure 3, the water content at 90~105 cm in three treatments shows the consistent general trend of change from October 2010 to October 2011 and it increases first and then decreases with time. With different ranges of change, the water content of T0 treatment is between 0.17 m$^3$·m$^-3$ and 0.28 m$^3$·m$^-3$, while the water content of T1 and T2 treatments is between 0.28 m$^3$·m$^-3$ and 0.44 m$^3$·m$^-3$. The soil moisture content at 90~105 cm is less affected by crop roots, which is mainly affected by rainfall infiltration, while the larger difference of water content between T0 treatment and T1/T2 treatment may be affected by spatial difference.

![Graphs showing soil moisture content changes](image2)
4. Conclusion

1) The soil moisture content varies in different soil layers under different planting patterns, and the water content of T0, T1 and T2 treatments reaches the highest at 90-105cm, which are 0.28 m$^3$·m$^{-3}$, 0.44 m$^3$·m$^{-3}$ and 0.44 m$^3$·m$^{-3}$ respectively.

2) From the characteristics of soil moisture with the change of time at different soil layers, before sowing spring maize, the soil moisture content of T0 and T2 planting patterns decreases with the increase of time, and the T1 planting pattern changes little with the increase of time. In the maize growing season, the soil moisture content of T0, T1 and T2 planting patterns is consistent with the trend of time.

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