Effects of Field Management Measures on Soil Nutrient Changes During Fallow Period in Irrigated Area of Arid Oasis

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Abstract. In order to evaluate the status and change tendency of soil nutrients during fallow period in Minqin Lvzhou Irrigation area, different treatment of field management measures and irrigation scheme were designed to determine the soil nutrient status and main component contents in the fallow period of wheat and corn from harvest to sowing in the next year, and analyze the dynamic change In Hongyashan irrigation area, Minqin County, Shiyang River basin. The results showed that soil organic matter, total nitrogen and available potassium increased before freezing, but decreased from the maximum after freezing and thawing. The alkali-hydrolyzed nitrogen is always increasing before freezing to after freezing and thawing. Available phosphorus fluctuates greatly. Autumn tillage in wheat field affected the profile distribution of total nitrogen, alkali-hydrolyzed nitrogen and available phosphorus, but the effects were basically eliminated before soil freezing. The contents of organic carbon, organic matter, total nitrogen and alkali-hydrolyzed nitrogen in soil were significantly reduced by winter irrigation, while total phosphorus was increased significantly, and the other components was irregularly changed.

Keywords: Fallow period of farmland; Field management measures; Soil nutrient

1 Introduction

Soil nutrient is an important index of soil fertility and a necessary nutrient element for plant growth provided by soil. Its content varies with soil type and region, and mainly depends on the parent material type, organic matter content and human factors. The nutrient status in the fallow period of farmland plays a decisive role in fertilization and crop planting in the next planting period. Therefore, the study of soil nutrient change rules and influencing factors in the fallow period is of great importance for arranging reasonable field management measures in the fallow period, evaluating soil suitability for tillage, selecting suitable crops in spring, and improving nutrient use efficiency. The contents of organic carbon, total nitrogen, total phosphorus and total

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sulphur, which were the main nutrients of soil, generally decreased with increasing depth in soil profile [1]. The influence of land use and tillage on soil is mainly manifested in the degree of soil disturbance and the presence of residue, which leads to the leaching of soil nutrients [2]. In recent years, farmland cultivation has gradually changed from the traditional way to the direction of less tillage or no tillage. No-tillage has the advantages of reducing erosion, saving energy and helping soil water infiltration. The increase of water infiltration did not cause nitrogen leaching. The research results showed that the leach of nitrate nitrogen below 150cm with no-tillage method was lower than that of traditional method. Tillage methods affect nitrogen leaching: ridge tillage is lower than share plow, share plow is lower than no tillage, no tillage is lower than chisel plow. Precipitation and irrigation can cause nutrient leaching and change nutrient distribution. Soil soluble nutrients are transported downward by water. Only when soil moisture is saturated can nutrients be leached. Research has shown that soil nitrate nitrogen descends to a depth of l~1.5m, sometimes 2 m, every 2 to 3 mm precipitation causes soil nitrate nitrogen to shift down 1 cm. Short-term freeze-thaw cycles affect the characteristics of soil water-heat conduction, solute transport and water infiltration [3-5]. The freeze-thaw process will enhance the nitrification of soil and promote the release of dissolved organic acids, resulting in a decrease in the pH of soil solution. Freeze-thaw can increase the mineralization rate of soil organic carbon (SOC), resulting in the differentiation between the fixation and activation of SOC components. By changing the physical and chemical properties and biological properties of soil, the freeze-thaw cycle affects the migration and transformation direction and occurrence form of nitrogen and phosphorus, as well as the emission of greenhouse gas N_2O [6-7]. Li Quanqi et al. [8] studied the dynamic changes of soil nutrient content in topsoil under mulching and irrigation conditions in the early sowing period of winter wheat and concluded that irrigation in mulching fields did not significantly reduce organic matter, but increased the content of alkali-hydrolytic nitrogen, and significantly increased the content of available phosphorus and available potassium. Chen Mengnan et al. [9] studied the effects of different tillage modes on soil moisture, nutrients and yield in wheat fields during the fallow period, and showed that deep ploughing/deep ploughing, deep loosening/deep ploughing and deep loosening /deep loosening could improve nutrient supply and promote dry matter accumulation in wheat. According to Lu Mei et al. [10], deeper tillage in fallow period reduced the content of alkali-hydrolyzed nitrogen, available phosphorus, organic matter and phosphatase activity in soils of 0 ~ 20 cm and 20 ~ 40 cm in each growth period, and improved the water use efficiency, nitrogen use efficiency and phosphate productivity of wheat fields in rainfed area. Liu Xiaodong et al. [12] studied the spatial-temporal variation of soil nutrients in farmland of Minqin oasis, and concluded that the mean contents of organic matter, available nitrogen and available phosphorus in soil increased from 1980 to 2006, while the mean values of available potassium decreased. Literature [13-16] studied the nutrient status of cultivated soil in Hexi area of Gansu Province and evaluated the abundance and deficiency of cultivated soil nutrients in different regions. Literature [17-20] studied the dynamic changes of soil nutrients in retired farmland and wasteland in Minqin area. There is a long history of research on soil nutrients in cultivated land, and there are many research results on specific regional land use patterns. However, the research on soil nutrient status and its change in fallow period of cultivated land is mainly based on rainfed area. The main focus was the effects of field management measures on the nutrient status during the growth period, rather than the dynamic changes of recreational nutrients. The research results related to this study area mainly focus on nutrient status and evaluation of retired farmland and wasteland. Less attention was paid to the nutrient dynamics of cultivated land during the fallow period of 7-8 months without vegetation. The research results are not enough to guide agricultural practice. This study selected representative field management measures and irrigation scheme as treatment in Minqin area of Shiyang River basin, Gansu Province, and measure the dynamic change of the main components of soil nutrients in the fallow period and study its interannual change regularity to provide technical reference for improving soil nutrient utilization efficiency.

2 Materials and Methods

2.1 Overview of the Test Area

The experiment was conducted in Minqin water-saving agriculture and ecological construction experimental demonstration base of Gansu Institute of Water Resources Science, which is located at Datan Township, Minqin County (103°36 'east longitude, 39°03' north latitude). It is a continental desert area with dry climate, low rainfall, strong evaporation, large temperature difference between day and night, and long sunshine time. The annual average precipitation is about 110mm, and most of it is ineffective rainfall which is difficult for crops to use. The precipitation from July to September accounts for 60% of the annual precipitation, and the annual evaporation is 2644 mm. The sunshine time is more than 3010 h, and the accumulated temperature(n>10°C) is 3147.8 °C.

2.2 Test Treatment Design

6 treatments were designed in the field test, of which 4 were in wheat field and 2 were in corn field. The 6 treatments were designed with different combinations of local common field management practices and winter irrigation plans. 2 treatments of wheat fields were no-tillage with coverage of wheat straw. Between them, one is irrigated and the other is not. 2 treatments of wheat fields were tillage in autumn, one is irrigated and the other is not. 2 treatments of corn fields were no-tillage with coverage of corn straw. Between them, one is irrigated and the other is not. Autumn tillage was carried using machine on August 13, 2019, and the ploughing depth is 30 cm. the ground was raked after ploughing. The irrigation was applied on October 27, 2019, and border irrigation was used. Test treatment design is shown in Table 1.

Table 1. Treatment design of field test.

Treatment	Field type	Management measures	Irrigation qutao(m^3/hm^2)
Txm-1	wheat	tillage	
Txm-2	wheat	tillage	1500
Txm-3	wheat	cover	
Txm-4	wheat	cover	1500
Tym-1	corn	cover	1500
Tym-2	corn	cover	

2.3 Observation Items and Methods

The experimental observation period was from July 21, 2019, to April 30, 2020 for wheat field and September 29, 2019 to April 30, 2020 for corn field. The main observation items of the experiment were content of soil nutrient organic carbon, organic matter, total nitrogen, total phosphorus, alkali-hydrolyzed nitrogen, available phosphorus, available potassium. The physical properties such as soil water content were also measured in the supported project. Nutrients were measured in a layer every 10 cm in the 0-40 cm profile and a layer every 20 cm within 40-100 cm. The dates were 27 October 2019 and 9 November 2019, 21 March 2020 and 30 April 2020. Initial values of straw cover treatment were measured on July 21, 2019 and that of tillage treatment were August 14, 2019. For all observation items, three parallel samples were taken at selected locations for experimental analysis.

Organic carbon was determined by sulfuric acid and potassium dichromate oxidation (oil bath) -titration method. Total nitrogen was determined by Kay distillation, alkali-hydrolyzed nitrogen was determined by alkali-diffusion. Available phosphorus was determined by sodium bicarbonate extraction (1:20) -molybdenum-antimony resistance colorimetric method (neutral, calcic soil), and available potassium was determined by ammonium acetate exchange (1:10) -flame spectrophotometry.

2.4 Data Processing

IBM SPSS Statistics 22.0 software was used for data processing and calculation of statistical indicators and significance test. Charts were drawn using Macrosoft Excel 2016.

3 Result and Analysis

3.1 Profile Distribution of Soil Nutrients

Soil nutrients were significantly affected by field management practices. The distribution of soil nutrients along the depth direction was consistent in the 6 treatments during fallow period. The contents of organic carbon, organic matter, total nitrogen, total phosphorus, alkaline nitrogen, available phosphorus and available potassium in soil nutrients were distributed along the depth in accordance with the trend of higher at the top and lower at the bottom, whether treatment is tillage in autumn or covering by straw, also is irrigated or not. That is, content of soil nutrient decrease from the top layer the bottom. The profile distribution of each component of soil nutrient after tillage on August 13, 2019 was drawn by Txm-1 treatment, as shown in Figure 1 to Figure 3.

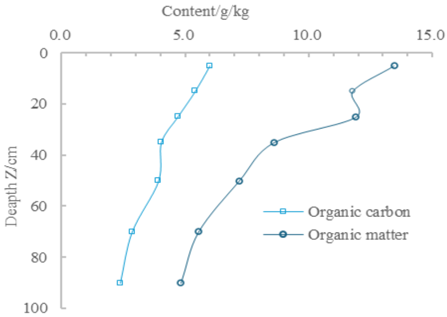

Fig. 1. Original content profile of organic carbon and organic matter in treatment Txm-1

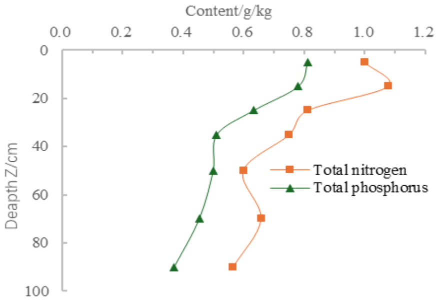

Fig. 2. Original content profiles of organic carbon and organic matter of treatment Txm-1

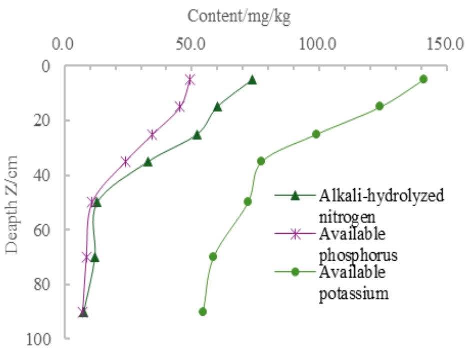

Fig. 3. Original content profiles of available alkali-hydrolyzed nitrogen, available phosphorus and available potassium of treatment Txm-1

3.2 Changes of Soil Nutrients During Fallow Period

There is a long fallow period in the farmland of Shiyang River basin. In the Minqin region, spring wheat is planted in late March and harvested in late July. In Minqin county, spring wheat is sown in late March and harvested in late July every year. The fallow period is as long as 8 months. Maize is sown from mid to late April and harvested in late September, with a fallow period of seven months. During the long fallow period, fields need to be managed differently depending on the type of crop to be planted next year. Such as deep ploughing, covering, grinding and harrowing, etc, irrigated with different schedule (winter irrigation, spring irrigation). These conventional measures not only increase soil water content to ensure better soil moisture in the next year's sowing, but also have a significant impact on the physical and chemical properties of the soil. The influence on chemical properties is more significant than physical properties, especially irrigation will dissolve nutrients and bring nutrients into the deep layer of soil. Taking treatment Txm-3 as an example, the profile changes of organic matter, total nitrogen, alkali-hydrolyzed nitrogen, available phosphorus and available potassium over time were drawn, as shown in fig. 4-8.

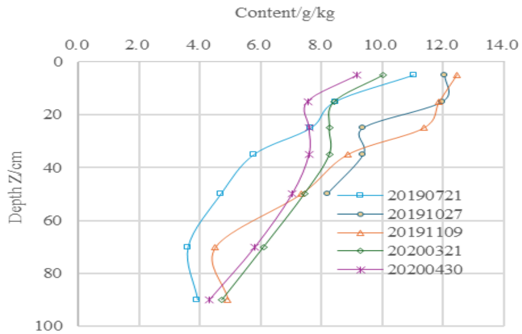

Fig. 4. Profile distribution of soil organic matter content during the fallow period in treatment Txm-3

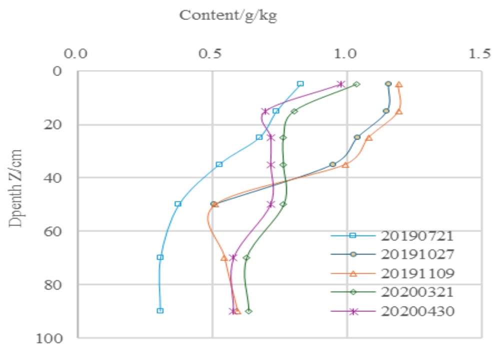

Fig. 5. Profile distribution of total nitrogen content in the fallow period of treatment Txm-3

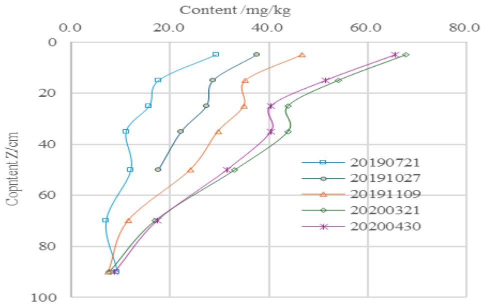

Fig. 6. Profile distribution of soil alkali-hydrolyzed nitrogen content in fallow period of treatment Txm-3

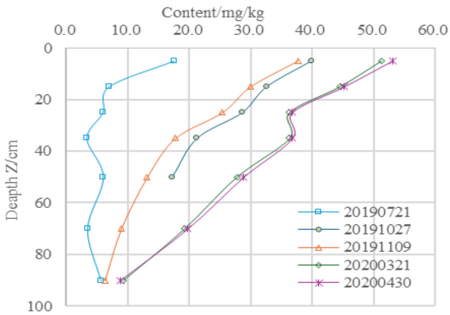

Fig. 7. Profile distribution of available phosphorus content in fallow period of treatment Txm-3

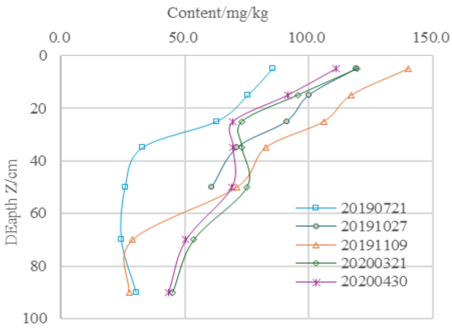

Fig. 8. Profile distribution of soil available potassium content in fallow period of treatment Txm-3

It can be seen from above figure that the organic matter profile, total nitrogen and available potassium profile of treatment Txm-3 have been increasing from July 21 to October 27 and then to November 9, reaching its maximum as the seasonal freeze-thaw process begins. Then it gradually decreases. Alkaline nitrogen increased significantly from July 21 to March 21 of the following year. After spring irrigation, it decreased slightly until April 30. Available phosphorus fluctuated the most, increasing from July 21 to October 27 and decreasing slightly from November 9, then increased significantly on March 21 and slightly on April 30 of the next year, indicating that it was not affected by irrigation.

3.3 The Effects of Different Field Management Measures on Soil Nutrients

3.3.1 Effects of Autumn Tillage on Soil Nutrients

To analyse the effects of different field management measures on nutrients, the nutrient observation results of each treatment on October 27, 2019, were statistically analyzed, and the significance of differences among different measures were tested, as shown in Table 2. According to the table, there are some differences in the profile distribution of soil nutrient content among the different field management measures. Comparative analysis of soil nutrient status in 0-40cm soil layer, the contents of organic carbon, organic matter and total nitrogen in wheat fields without tillage (Txm-1, Txm-2) were higher than those in wheat fields treated with autumn tillage (Txm-3, Txm-4). The difference of organic carbon contents and organic matter was small, but the difference of total nitrogen was significant ($P < 0.05$). The contents of total phosphorus, alkali-hydrolytic nitrogen and available phosphorus in wheat field treated with autumn tillage (Txm-3, Txm-4) were higher than those in wheat field treated with no tillage (Txm-1, Txm-2). The available potassium content was no significant difference. Comparative analysis of the basic nutrient values on July 21, 2019 and values after autumn tillage on August 14, 2019, the nutrient increase of no-tillage treatment was significantly higher than that of autumn tillage treatment. The main reason is that tillage changes the nutrient distribution, destroys the original structure and pores of soil, and affects the capillary water rise and nutrient transport.

Table 2. Soil nutrient distribution under different field management practices on October 27, 2019

Deapth/cm	**Management measure**	**Organic carbon g/kg**	**Organic matter g/kg**	**Total nitrogen g/kg**	**Total phosphorus g/kg**	**Alkali-hydrolyzed nitrogen mg/kg**	**Available phosphorus mg/kg**	**Available potassium (mg/kg)**
0-10	tilled wheat field	6.76±0.57ab	11.65±0.98ab	0.96±0.04b	0.82±0.02a	49.18±8.62a	43.8±2.36a	115.25±6.4ab
	covered wheat field	7.39±0.49a	12.74±0.85a	1.11±0.06a	0.80±0.03ab	36.58±1.9b	42.31±3.36a	123.5±5.97a
	covered corn field	6.41±0.43b	11.05±0.74b	0.91±0.1b	0.78±0.01b	43.6±2.28ab	47.3±4.57a	110.5±8.06b
10-20	tilled wheat field	5.77±0.1b	9.95±0.17b	0.93±0.14b	0.77±0.01a	41.85±6.39a	39.06±2.86ab	101±5.72a
	covered wheat field	6.99±0.63a	12.05±1.08a	1.09±0.07a	0.72±0.03b	32.93±4.93b	35.45±3.4b	100±2.31a

	covered corn field	5.66±0.21b	9.75±0.37b	0.79±0.06b	0.69±0.01c	38.88±1.94ab	41.83±3.21a	105.5±3.11a
20-30	tilled wheat field	5.42±0.14ab	9.34±0.24ab	0.77±0.03b	0.68±0.06a	37.23±3.31a	34.17±2.36a	90.25±5.91a
	covered wheat field	5.89±0.65a	10.16±1.12a	0.93±0.13a	0.63±0.02a	27.15±1.14b	28.85±1.25b	89.75±2.99a
	covered corn field	4.79±0.27b	8.26±0.47b	0.78±0.02b	0.65±0.02a	36.9±4.16a	34.59±1.95a	84.5±8.06a
30-40	tilled wheat field	4.74±0.32a	8.18±0.55a	0.64±0.11b	0.55±0.07a	23.28±3.07a	24.72±2.23ab	72.75±7.27a
	covered wheat field	5.13±0.62a	8.84±1.07a	0.88±0.09a	0.52±0.01a	23.35±1.45a	21.77±0.86b	64.75±7.54a
	covered corn field	4.81±0.27a	8.29±0.47a	0.72±0.06b	0.56±0.06a	25.68±1.41a	26.18±2.43a	75.5±5.92a

Note: Different lowercase letters denote statistically significant differences among treatments at the 0.05 probability level.

The effect of autumn tillage on soil nutrients lasted until the end of freezing and thawing. The soil nutrient contents on November 9, 2019 and March 21, 2020 were analysed, and the results are shown in Table 3 to Table 4. It is easy to find by comprising treatment Txm-1 and Txm-3 that there are still difference of nutrient content in 0-20cm soil layer. The situation is similar that on October 27, 2019. There is no significant difference in nutrient content of 20-40cm soil layer. Comprising nutrient content of 2 treatments on March 21, 2020, the contents of organic carbon, organic matter and total nitrogen of Txm-1 in 0-40cm soil layer were higher than those of Txm-3. The contents of total phosphorus and alkali-hydrolyzed nitrogen of treatment Txm-3 were higher than those of Txm-1. There was no significant difference between available phosphorus and available potassium. The main reason for this change was the release of nutrients from freeze-thaw and the effect of solidification. The observation data on April 30, 2020, showed that the distribution of nutrient profile in each treatment was the same as that measured on March 21, 2020, and the value was slightly smaller than that on March 21, 2020.

3.3.2 The Influence of Irrigation on Soil Nutrients

Irrigation will cause the redistribution of nutrients in the soil profile, which will inevitably have an impact on nutrients. In this experiment, irrigation was performed after the observation on October 27, 2019, therefore, the nutrient content on November 9, 2019, can reflect the direct impact of irrigation. The data in Table 3 were used to analyze the nutrient differences between irrigated and non-irrigated treatments. The contents of organic carbon, organic matter, total nitrogen and alkali-hydrolyzable nitrogen in 0-10 cm, 10-20 cm and 20-40 cm soil layers in the treatment Txm-1 and

Txm-3 (maize field treatment) significantly decreased after irrigation, while total phosphorus increased significantly, there was no obvious change and significant difference in other nutrient components. The contents of organic carbon, organic total phosphorus and available potassium in 0-10 cm, 10-20 cm and 20-40 cm soil layers in maize field treatment decreased significantly after irrigation while total nitrogen increase significantly. There was no significant difference in other nutrient components.

Irrigation also influenced the subsequent changes of soil nutrients. By compressive analyzing the soil nutrient status after thawing in Table 4, it can be found that in 0-10 cm and 10-20 cm soil layers the contents of organic carbon, organic matter and total nitrogen of no-irrigation treatment Txm-1 were significantly higher than those in the irrigation treatment Txm-2. There was no significant difference in other nutrient components. In the 20-40 cm soil layer, the contents of organic carbon, organic matter and alkali-hydrolyzed nitrogen of no-irrigation treatment Txm-1 were significantly lower than those treated irrigation treatment Txm-2, and there was no significant difference in other nutrient components. For the no-tillage treatment, in 0-10 cm and 10-20 cm soil layers the soil layer, the contents of organic carbon, organic matter and alkali-hydrolyzed nitrogen of no-irrigation treatment Txm-1 were significantly lower than those treated irrigation treatment Txm-2, and there was no significant difference in other nutrient components. For the no-tillage treatment, in 0-10 cm and 10-20 cm soil layers the contents of organic carbon, organic matter and total nitrogen of no-irrigation treatment Txm-3 were significantly higher than those of irrigation treatment Txm-4, and there was no significant difference in other nutrient components. In 20-40cm soil layer the contents of organic carbon, organic matter and total phosphorus treatment Txm-3 were significantly higher than those treatment Txm-4. The content of total nitrogen, alkali-hydrolyzed nitrogen and available phosphorus of treatment Txm-3 were significantly lower than that of treatment Txm-4. Available potassium was at the same level. About that of maize field treatment, in the 0-10cm soil layer the content of total nitrogen and available potassium treated by irrigation were higher than those without irrigation, and there was no significant difference in other components. In the 10-20 cm and 20-40 cm soil layers, all nutrient components of irrigation treatment Tym-1 were higher than that of non-irrigation treatment. Tym-2 except for alkaline hydrolyzable nitrogen. The main reason of the difference in response to irrigation between wheat field treated with no tillage and autumn tillage is that the soil treated was relatively loose and thawing fast. The distribution of nutrient profiles in each treatment on April 30, 2020 was the same as that on March 21, 2020.

Table 3. Nutrient content differences of different field management practices on November 9, 2019

Deapth cm	**Treatment**	**Organic carbon g/kg**	**Organic matter g/kg**	**Total nitrogen g/kg**	**Total phosphorus g/kg**	**Alkali-hydrolyzed nitrogen mg/kg**	**Available phosphorus mg/kg**	**Available potassium mg/kg**
0-10	Txm-1	7.81±0.09b	13.45±0.16b	1.00±0.03c	0.81±0.01a	73.8±3.96a	49.07±2.3b	141.00±2.83b
	Txm-2	6.15±0.16d	10.6±0.27d	0.94±0.03d	0.87±0.01a	51.05±3.18b	44.68±1.39bc	130.5±3.54b

	Txm-3	7.23±0.11c	12.45±0.18c	1.19±0.03a	0.82±0.06a	46.75±0.21bc	37.75±5.28c	140.00±4.24b
	Txm-4	6.04±0.09d	10.41±0.16d	1.09±0.01b	0.85±0.01a	41.25±2.76c	43.58±3.25bc	153.00±5.66a
	Tym-1	5.99±0.06d	10.33±0.1d	1.02±0.01c	0.82±0.01a	50.5±1.7b	45.23±2.08bc	139.00±5.66b
	Tym-2	9.28±0.04a	16.00±0.07a	0.82±0.01e	0.81±0.02a	48.2±1.56b	66.41±2.31a	119.5±3.54c
10-20	Txm-1	6.83±0.21b	11.78±0.37b	1.08±0.05b	0.78±0.01ab	60.00±1.7a	45.28±0.06ab	124.00±4.24a
	Txm-2	5.89±0.1c	10.16±0.18c	0.81±0.00c	0.81±0.00a	44.05±1.34b	39.55±5.38b	114.00±2.83b
	Txm-3	6.88±0.17b	11.87±0.29b	1.19±0.03a	0.76±0.04ab	35.3±1.84c	30.01±0.14c	117.00±2.83ab
	Txm-4	4.18±0.04d	7.20±0.06d	1.06±0.00b	0.75±0.04ab	45.00±0.57b	40.69±3.02b	120.00±4.24ab
	Tym-1	6.03±0.56c	10.39±0.96c	0.85±0.03c	0.72±0.02b	46.1±1.27b	51.44±1.34a	126.00±4.24a
	Tym-2	9.08±0.06a	15.66±0.1a	0.75±0.01d	0.71±0.01b	44.55±0.64b	42.1±1.58b	120.00±4.24ab
20-40	Txm-1	5.95±1.11a	10.25±1.92a	0.78±0.04bc	0.57±0.07b	42.45±11.35a	29.26±6.29a	88.25±12.66a
	Txm-2	4.02±0.51b	6.94±0.88b	0.64±0.12d	0.71±0.07a	33.33±9.62a	30.84±9.18a	104±11.11a
	Txm-3	5.87±0.84a	10.12±1.45a	1.04±0.05a	0.6±0.07ab	32.33±3.79a	21.58±4.42a	94.25±13.84a
	Txm-4	3.46±0.78b	5.96±1.34b	0.84±0.01b	0.6±0.06ab	32.3±2.11a	25.07±2.27a	87.75±21.41a
	Tym-1	4.34±0.16b	7.48±0.27b	0.8±0.02bc	0.6±0.08b	35.45±4.4a	33.17±11.41a	87.5±6.19a
	Tym-2	5.77±1.58a	9.94±2.72a	0.72±0.06cd	0.66±0.02ab	41.7±11.59a	32.04±5.11a	100.25±6.6a

Table 4. Nutrient content differences of different field management practices on March 21, 2020

Deapth cm	Treatment	Organic carbon g/kg	Organic matter g/kg	Total nitrogen g/kg	Total phosphorus g/kg	Alkali-hydrolyzed nitrogen mg/kg	Available phosphorus mg/kg	Available potassium mg/kg
0-10	Txm-1	6.18±0.11b	10.66±0.2b	1.35±0.00a	0.67±0.00	64.5±1.41abc	48.59±0.81a	123.5±2.12ab
	Txm-2	5.86±0.01c	10.11±0.02c	1.06±0.02bc	0.67±0.02	68.1±0.71bc	50.92±1.56a	127.5±2.12a
	Txm-3	5.81±0.08c	10.02±0.15c	1.04±0.01c	0.68±0.01	67.7±2.69abc	51.32±2.21a	119.5±2.12bc
	Txm-4	6.47±0.07a	11.16±0.13a	1.1±0.04b	0.69±0.01	67.3±3.54ab	52.99±0.47a	117.5±2.12c
	Tym-1	5.80±0.03c	10.00±0.04c	0.94±0.02d	0.65±0.02	51.15±0.64c	53.47±0.99b	120.5±2.12bc
	Tym-2	5.90±0.10	10.18±0.	0.87±0.0	0.71±0.01	55.8±0.71a	42.43±0.45	105.5±2.12

		c	18c	1e			b	d
10-20	Txm-1	5.4±0.11a	9.31±0.2a	1.09±0.00a	0.58±0.01d	60.4±1.41a	44.73±1.53c	91.5±2.12ab
	Txm-2	5.09±0.01b	8.78±0.03b	0.94±0.01b	0.61±0.01d	57.4±1.41ab	44.71±1.68c	86.5±2.12c
	Txm-3	4.88±0.06c	8.42±0.11c	0.81±0.02c	0.7±0.02ab	54.05±2.33b	44.53±0.7c	95.5±2.12a
	Txm-4	5.10±0.04b	8.80±0.08b	1.07±0.05a	0.67±0.01bc	53.75±1.48b	48.11±1.15b	91.5±2.12ab
	Tym-1	4.29±0.06d	7.40±0.09d	1.12±0.01a	0.71±0.01a	45.85±2.9c	59.82±0.91a	93.00±1.41a
	Tym-2	4.19±0.1d	7.23±0.17d	0.76±0.01c	0.65±0.00c	46.5±0.71c	32.76±1.34d	87.00±1.41bc
20-40	Txm-1	5.40±0.11a	9.31±0.2a	1.09±0.00a	0.58±0.01d	60.4±1.41a	44.73±1.53c	91.5±2.12ab
	Txm-2	5.09±0.01b	8.78±0.03b	0.94±0.01b	0.61±0.01d	57.4±1.41ab	44.71±1.68c	86.5±2.12c
	Txm-3	4.88±0.06c	8.42±0.11c	0.81±0.02c	0.7±0.02ab	54.05±2.33b	44.53±0.7c	95.5±2.12a
	Txm-4	5.10±0.04b	8.80±0.08b	1.07±0.05a	0.67±0.01bc	53.75±1.48b	48.11±1.15b	91.5±2.12ab
	Tym-1	4.29±0.06d	7.40±0.09d	1.12±0.01a	0.71±0.01a	45.85±2.9c	59.82±0.91a	93.00±1.41a
	Tym-2	4.19±0.1d	7.23±0.17d	0.76±0.01c	0.65±0.00c	46.5±0.71c	32.76±1.34d	87.00±1.41bc

3.3.3 Differences of Soil Nutrients Between Maize and Wheat Fields

In the experimental area, maize was harvested in late September, two months later than wheat, so the fertility recovery was significantly lower than that of wheat. The nutrient contents of each treatment on October 27, 2019 were statistically analyzed. The differences between wheat field (Txm-3, Txm-4) and corn field (Tym-1, Tym-2) were shown in Table 3. It can be seen from the table that in 0-10 cm, 10-20 cm and 20-30 cm soil layers, the contents of organic carbon, organic matter, total nitrogen and available potassium in corn field were significantly lower than those in wheat field. the contents of other nutrient components were little difference. There was no significant difference in 30-40 cm soil layer. Continually to analyze the differences of nutrient contents after thawing on March 21, 2020 shown that the content of organic carbon, organic matter, total nitrogen, alkali-hydrolyzed nitrogen and available potassium in maize field were still lower than those in wheat field. This is caused by the difference initial values.

4 Discussion

4.1 The Pattern of Soil Nutrients Changes During Fallow Period

The contents of organic carbon, total nitrogen, total phosphorus and total sulphur in the soil profile generally decreased with the increase of depth. This is a conclusion that has been proved by existing research results [1]. The results of this experiment show that the soil nutrient profile is in accordance with this rule. During the long fallow period of seven months, the physical and chemical properties of the soil are constantly changing, where the chemical properties change more obviously. The changes of the nutrient profile rule are: The content of organic matter, total nitrogen and available potassium keep growing until soil freezing and reach to maximum. Affected by seasonal freezing-thawing process, it gradually decreases after soil thawing. The content of alkali-hydrolyzed nitrogen increased continuously before freezing to thawing on March 21 of the next year, and then decreases slightly. Content of available phosphorus fluctuated before freezing and increased after March 21 of the following year. The process changes of soil nutrients in no-tillage farmland were mainly affected by seasonal freeze-thaw. The change pattern motioned above is basically consistent with the conclusions of references [6-7].

4.2 Effects of Field Management Measures on Nutrient Change

Tillage methods can cause soil disturbance and residue presence, which can affect soil nutrient leaching [2]. In this study, autumn tillage affects nutrient profile distribution at the beginning. The content of total nitrogen, alkali-hydrolyzed nitrogen and available phosphorus in 0-10 cm soil layer is lower than that in 10-20 cm soil layer in the autumn tillage treatment of wheat field. However, this effect was eliminated by 27 October. Because the study area is in the inland arid area, there is less precipitation in the fallow period, and irrigation is the main factor causing nutrient leaching. According to the comparative analysis of irrigation treatment and non-irrigation treatment in wheat field in this study, Under the condition of unchanged field management measures, there were significant differences in nutrients content between irrigated and non-irrigated treatments. The contents of organic carbon, organic matter, total nitrogen and alkali-hydrolyzed nitrogen in tillage soil layer decreased significantly. Total phosphorus increased significantly, while other components had no obvious changes. This conclusion is basically consistent with the research results in reference [2] and reference [8]. However, it is different from the research results in reference [8] about alkali-hydrolyzed nitrogen. The research object of reference [8] was the winter wheat with coverage at the early sowing stage。

5 Conclusion

The following conclusions can be drawn from the research and analysis of this paper:

• In the fallow period of irrigated farmland in arid oasis area, the main soil nutrients, total nitrogen and available potassium were increasing before freezing. Affected by the seasonal freeze-thaw process, it gradually decreases after the end of freeze-thaw. Alkali-hydrolyzed nitrogen increased throughout the fallow period while available phosphorus fluctuates greatly, increasing and decreasing before freezing.

• Tillage measures affected nutrient profile distribution in wheat field at the initial stage. Among them, total nitrogen, alkali-hydrolyzed nitrogen and available phosphorus were more significant, but the effects disappeared in 2-3 months. Therefore, tillage of wheat fields during fallow period will not affect the soil fertility and seeding of the following year.

• Irrigation can cause nutrient leaching. Make the contents of organic carbon, organic matter, total nitrogen and alkali-hydrolyzed nitrogen to decrease significantly, and total phosphorus to increase significantly. Therefore, the frequency of irrigation and amount of water application during the fallow period should be reduced as far as possible.

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