

Comparative analysis of soil infiltration under three types of land use

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Abstract. It is of great significance to understand the rule of soil infiltration to develop and better use of land resources or guide the agricultural irrigation. The grass infiltration apparatus is used to test the soil infiltration under different land uses, including grassland, woodland and vegetable land. The relationship between saturated water content and bulk density and their influence on soil infiltration were studied also. The main results are as follows: 1)The steady infiltration rate of grassland, woodland, and vegetable land soil are 1.87 mm/min, 0.39 mm/min, 6.93 mm/min respectively; The saturated moisture content are 23.41%, 27.53% and 28.78% respectively;The soil bulk density was 1.61g/cm³, 1.46g/cm³ and 1.43g/cm³ respectively.2)The steady infiltration rate and saturation moisture content are positively correlated. 3)The weight of soil is negatively correlated with the saturated moisture content. These results can provide useful information for land improvement, water and soil management practices.

Introduction

The rapid economic development, people's living level gradually improve, however, water shortage, water quality deterioration, land degradation and environmental deterioration and other issues has seriously affected the economic development and social stability of our country, how to solve the shortage of water and soil resources and the deterioration of agricultural sustainable development in our country has important significance[1-5].To improve the utilization of rainwater resources and make full use of the limited water resources, the development of low-water agriculture has become an international subject[6-9].

Soil infiltration is the process of liquid water entering the soil, which is an important link in the natural water cycle[10].The infiltration rate of soil is determined by the degree of moisture and porosity of the soil. For example, the soil infiltration capacity of dry, coarse texture and good structure is strong, whereas the infiltration capacity is weak[11].It is of great practical significance to study how the soil infiltration performance can reduce rainfall, increase infiltration, and reduce surface runoff to soil erosion.

According to the soil infiltration law of different land use mode research, scholars in our country mostly adopts double loop method, artificial rainfall, hydrological method, etc.[12], it is rare to see someone with grass infiltration apparatus for determination of rainfall infiltration.It is a good choice to measure soil permeability in the field because it is convenient to carry and easy to operate.In this paper,it will use grass infiltration apparatus measuring infiltration law of soil under different land use modes, and analyzes the relationship between saturated moisture content and bulk density and their influence on infiltration condition, verify whether the conclusions are consistent.

Materials and methods

The soil in the soil of grassland, woodland soil and vegetable soil were soil, and the basic situation was shown in table 1.

Table 1 The basic situation of the soil used for testing

Land use mode	Sampling point	Latitude and longitude	altitude	Air pressure	slope	pH
grassland	(P ₁)	29°48'50"N 106°24'44"E	190.3m	985.9hPa	0°-1°	5.54
	(P ₂)	29°48'49"N 106°24'44"E	190.2m	985.9hPa	0°-2°	
	(P ₃)	29°48'50"N 106°24'44"E	209.9m	986.0hPa	0°-2°	
woodland	(P ₁)	29°49'06"N 106°24'49"E	231.1m	981.3hPa	0°-1°	5.21
	(P ₂)	29°49'06"N 106°24'50"E	230.0m	981.3hPa	0°-2°	
	(P ₃)	29°48'48"N 106°24'41"E	231.7m	984.2hPa	0°-8°	
vegetable land	(P ₁)	29°49'11"N 106°24'49"E	272.5m	981.6hPa	0°-1°	5.99
	(P ₂)	29°49'11"N 106°24'49"E	272.6m	981.7hPa	0°-2°	
	(P ₃)	29°49'11"N 106°24'49"E	272.5m	981.6hPa	0°-2°	

In this paper, the saturated water content and bulk density of grassland, woodland and vegetable land were determined by drying method. The infiltration test was carried out in the field with Turf-Tec grass infiltration apparatus, its calculation formula is as formula (1).

$$f_0 = \frac{h_0}{t_0} \quad (1)$$

In formula: f_0 -- initial infiltration rate(mm/min); h_0 -- infiltration water level(mm); t_0 -- infiltration time(min).

Results and discussion

The infiltration results

The characteristic curve of soil water infiltration is shown in figure 1.

The initial infiltration rates of grassland, woodland and vegetable soil were 8.07mm/min, 6.50mm/min and 45.67mm/min respectively. The time of soil stabilization in grassland, woodland and vegetable soil was 100min, 80min and 80min respectively. Their infiltration rates were 1.87mm/min, 0.39mm/min and 6.93mm/min respectively. Visible on the test, the penetration of vegetable is the best, followed by the grass, finally the woodland, its steady infiltration rate is minimum, shows that woodland has the best capacity for water conservation(Fig.1).

The relationship between saturated water content, bulk density and steady infiltration rate

The results of saturated water content and bulk density of the three kinds of land use modes soil are shown in table 2.

Table 2 The analysis of soil steady infiltration rate, saturated moisture content and bulk density in grassland, woodland and vegetable land soil

Land use mode	steady infiltration rate (mm/min)	saturated moisture content (%)	bulk density (g/cm ³)
grassland	1.87	23.41	1.61
woodland	0.39	27.53	1.46
vegetable land	6.93	28.78	1.43

The fitting curve of the relationship between saturated water content and steady infiltration rate of three kinds of land use modes soil is shown in Fig.2, the relationship between bulk density and steady infiltration rate is shown in Fig 3, the relationship between bulk density and saturated water content is shown in Fig.4.

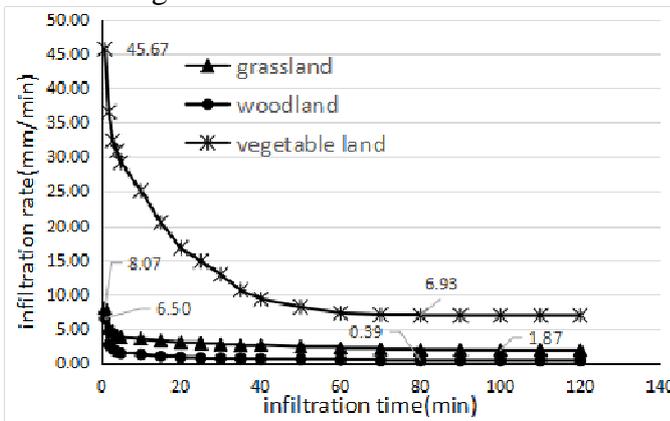


Fig.1. Soil moisture infiltration characteristic curve of grassland, woodland and vegetable land soil

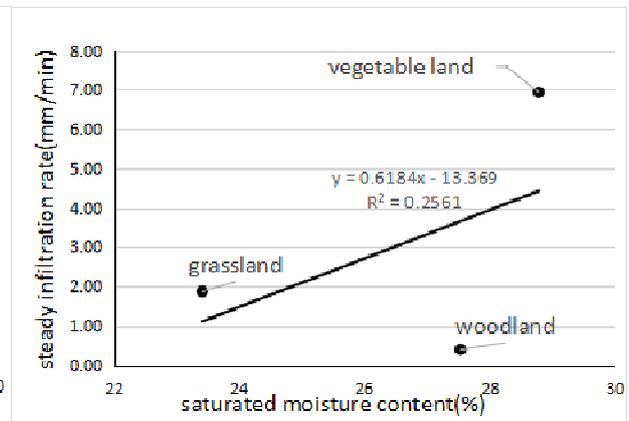


Fig.2. The relationship between saturated water content and steady infiltration rate of three kinds of land use modes soil

The steady infiltration rate is positively correlated with the saturated moisture content, and the saturated water content is high in the soil moisture permeability and soil moisture retention capacity, which is beneficial to water infiltration. But the correlation between the two is not high, the reason of this is that the soil type is less, and the rate of stability is higher. And we found there are more stones under the grass in the process of field experiment, it leads to the grassland soil porosity is larger, so there may be downstream in the process of infiltration water channel leads to steady infiltration rate is bigger (Fig.2).

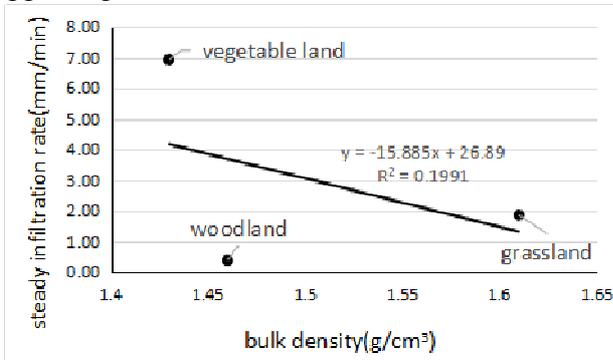


Fig.3. The relationship between bulk density and steady infiltration rate of three kinds of land use modes soil

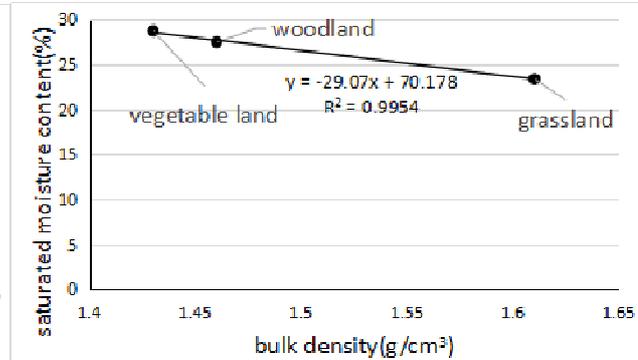


Fig.4. The relationship between saturated water content and saturated water content of three kinds of land use modes soil

Steady infiltration rate has negatively correlated with bulk density, because small soil bulk density, soil porosity, accordingly its penetration ability is strong (Fig.3).

There is a negative correlation between soil bulk density and saturated water content. Some studies have shown that the soil with higher bulk density has a relatively small porosity, and the water conductivity of soil is weakened accordingly. This is consistent with the results of this experiment (Fig.4).

Conclusions and recommendations

The experiment results show that: 1) The steady infiltration rates of grassland, woodland and vegetable soil were 1.87mm/min, 0.39mm/min and 6.93mm/min respectively; 2) The steady infiltration rate and saturation moisture content are positively correlated. The weight of soil is negatively correlated with the saturated moisture content.

And put forward two Suggestions.

1) The water head pressure is present in the determination of soil infiltration law by the sod, which results in the determination of the infiltration rate higher than the actual value, and how to eliminate this effect is still to be further studied.

2) Turf infiltration meter compared with double ring infiltration apparatus more convenient to carry, operating more simple, but through the literature found that now there are few scholars use grass infiltration apparatus measuring soil infiltration, so the future can promote grass infiltration apparatus used to measure soil water infiltration.

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