The Variation of Land Temperature in Different Years of Sandstone and Sand

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Abstract. In order to analyze the effect of different ages of sandstone and sand on soil temperature, this study selected the compound soil with 2 years of soil formation and 9 years of soil formation, using loess: sand 1:2, sandstone: sand 1:1, sandstone: sand 1:2, sandstone: sand 1:5, sandstone: sand 0:1 different proportions of soil for research, using geothermal meters for different soil layers (5cm, 10cm, 15cm, 20cm, 25cm) temperature observation. The results show that: 1. The variation of ground temperature in different soil layers of 2 and 9 years of soil formation shows 5cm>10cm>15cm>20cm≈25cm, the basic performance is that the temperature of the soil in the 9-year-old compounding soil is lower than the temperature of the soil for 2 years. 2. The soil of 2 years of soil formation is characterized by sandstone in different soil layers: sand = 1:2, the highest temperature, sandstone: sand = 0:1 compound soil temperature is the lowest; soil formation 9 years compounding The soil has the lowest loess in different soil layers: sand = 1:2, and the soil in different soil layers has better cushioning properties. 3. During the period from 8:00 to 20:00, with the change of measurement time, the trend of ground temperature change can be fitted by the polynomial equation y=ax²+bx+c, which is most obvious with 5cm soil layer, with soil layer As the depth increases, the slope of the polynomial curve gradually decreases. 4. In the soil of 9 years of compounding, the time when the sandstone of sandstone: sand = 1:1 soil reached its peak was postponed from 14:00 to 16:00, and the peak of loess: sand = 1:1 the original 16:00 point was delayed until 18:00, and the time when other compounded soils reached their peak was 16:00.

1. Introduction

Land temperature (ground temperature) refers to the temperature of soil at different depths below the ground, mainly refers to the temperature of shallow soil in the ground directly related to the growth and development of flowers and trees [1]. Ground temperature affects plant growth and development,
soil formation and soil shape, as well as various biochemical processes in the soil. It characterizes the thermal state of the soil [2].

The source of ground temperature is mainly from the radiation of the sun, bioheat and the internal heat of the earth. Studies have shown that shallow ground temperature includes soil temperature of 0cm-20cm on the ground, which is more affected by atmospheric temperature. Deep ground temperature includes soil temperature below 20cm, which is delayed by atmospheric temperature [3-5], the deeper the soil, the slower and slower the change in temperature, and the smaller the influence by the outside world [6]. The study on the seasonal variation of temperate monsoon climate shallow ground temperature shows that in spring and summer, the shallow ground temperature decreases with the increase of soil depth. In autumn and winter, the shallow ground temperature increases with the deepening of soil depth [7]. In fine weather, the surface and the atmosphere exchange energy, the surface heats up to the atmosphere, and the daily temperature change of the tillage layer profile tends to balance under the influence of the temperature gradient [8].

2. Materials and Methods

2.1. Test area overview

The test area is set at the Fuping pilot test base, located in Yucun Village, Fuping County, Weinan City, Shaanxi Province. The area is continental temperate semi-arid and semi-humid climate. The four seasons are dry, wet and warm, with an average annual precipitation of 472.8mm, an average annual temperature of 13.6°C, an average frost-free period of 226 days, and an average annual evaporation of 1257mm. The soil type in the test area is mainly loess.

2.2. Test design

This experiment was set up in the Fuping pilot site to simulate the soil environment of the Mu Us Sandy Land in the sandstone community. The sandstone and aeolian sand (sand) used in the experimental community are all from Dagehan Village, Xiaoji Khan Township, Yuyang District, Yulin City, Shaanxi Province. The surface layer of the cell is 0-30cm, which is a mixture of different proportions of sandstone (loess) and sand, 30-100cm completely filled with sand. The soil mixing ratio of the test soil is loess: sand 1:2, sandstone: sand 1:1, sandstone: sand 1:2, sandstone: sand 1:5, sandstone: sand 0:1. (Figure 1)

![Figure 1. Test soil ratio diagram.](image)

2.3. Measuring indicators and methods

The temperature of the soil at 5cm, 10cm, 15cm, 20cm and 25cm was measured by a right angle thermometer (MC30260139, China). The observation time was 8:00-20:00, and it was observed once every 2 hours. It is observed three times a month, which are early, middle and late.

2.4. Data Processing

The measured data were processed and analyzed by Excel 2017, and the index was fitted and plotted using Origin 9.0.
3. Results and Analysis

3.1. The variation of ground temperature under different soil layers in different compounding years

The variation of ground temperature in different soil layers of 2 and 9 years of soil formation shows 5cm>10cm>15cm>20cm≈25cm (Fig. 2, Fig. 3). When the sandstone: sand = 1:1, the temperature change of the compound soil in the 0-25cm soil layer between 2 and 9 years is between 25.47-36.99°C and 25.28-35.22°C, sandstone: sand = 1:2 between 26.11 - 37.88°C and 26.11 - 36.05°C, sandstone: sand = 1:5 between 26.44 - 37.82°C and 25.50 - 35.69°C, sandstone: sand = 0:1 between 27.02 - 33.96°C and 26.07 - 35.44°C, loess: sand = 1:2 between 24.97 - 37.37°C and 25.59 - 34.43°C. The basic performance is that the temperature of the soil in the soil for 9 years is lower than the temperature of the soil in the soil for 2 years. The temperature of the soil with different soil ages increased firstly and then decreased with time in the soil layer of 5cm. The temperature of other soil layers showed a gradually increasing linear relationship with time.

![Figure 2. The variation of ground temperature under different soil layers in 2 years of soil-forming soil.](image-url)
3.2. The variation of ground temperature under different soil layers in different compounding years

The two-year composite soil in the soil is expressed in different soil layers. The two-year composite soil in the soil is expressed in different soil layers. Sandstone: sand = 1:2 is the highest temperature, between 29.89 - 35.27°C, followed by sandstone: sand = 1:5 compound soil (29.79 - 34.85°C), sandstone: sand = 1:1 compound soil (29.27 - 34.51°C), loess: sand = 1:2 compound soil (29.18 - 34.49°C), sandstone: sand = 0:1 compound soil temperature is the lowest, between 29.14 - 32.05°C. Loess in each soil layer: the temperature difference of the soil with sand ratio of 1:2 is large, ranging from 4.87 to 6.4°C. In the 5cm, 10cm and 20cm soil layers, the temperature difference of the soil in the sandstone: sand=0:1 ratio is small, ranging from 3.27 to 4.16°C. In the 15cm soil layer, the temperature difference of the soil in the sandstone: sand=1:2 ratio is small, which is 0.63°C. In the 25cm soil layer, the temperature difference of the soil in the sandstone: sand=1:5 ratio is small, which is 4.23°C. (Figure 4)

In the 9-year-old compounded soil, the soil temperature of the loess: sand = 1:2 is the lowest in different soil layers. 5cm, 10cm and 20cm soil layers have the highest soil temperature in Sandstone:
Sand\(=0:1\). The 15cm and 25cm soil layers have the highest soil temperature in sandstone: sand\(=1:2\). The soil temperature difference of sandstone: sand\(=1:5\) in all soil layers is small, ranging from 2.41 to 3.14°C. The temperature difference of the sandstone: sand\(=1:1\) varies greatly, ranging from 5.27 to 6.38°C. It shows that the soil of sandstone: sand\(=1:5\) in different soil layers has better cushioning property. (Figure 5)

**Figure 4.** The variation of ground temperature under the same soil layer in the soil of two years of soil formation.
3.3. Diurnal variation of soil temperature in different soil layers under different compounding years

During the period from 8:00 to 20:00, with the change of measurement time, the trend of ground temperature can be fitted by the polynomial equation $y=ax^2+bx+c$, which is most obvious with 5cm soil layer, with the depth of the soil layer. As the depth of the soil increases, the slope of the polynomial curve decreases. The variation trend of ground temperature in different soil layers is $5\text{cm}>10\text{cm}>15\text{cm}>20\text{cm} \approx 25\text{cm}$. The ground temperature of 20cm and 25cm soil layers in all compounded soils is linear with time, and other soil layers are in a quadratic polynomial function relationship. In the soil of 2 years of soil formation, the sandstone: sand = 1:1 soil reached its peak at 14:00, and other soils peaked at 16:00. (Figure 6) With the increase of the age of soil formation, in the soil that has been compounded for 9 years, the time when the sandstone: sand = 1:1 soil reaches its peak is postponed to 16:00, and the peak of loess:sand=1:1 soil is delayed from the original 16:00 to 18:00. (Figure 7)
Figure 6. Diurnal variation of land temperature in two years of soil formation under different soil layers.
3.4. Diurnal variation of geothermal temperature of soils with different compounding years under the same soil layer

In the soil-filled soil in 2 years, the soil temperature in the 5-15cm soil layer varies greatly with the loess: sand = 1:2 ratio. In the 20-25cm soil layer, the temperature difference of the soil in the sandstone: sand=0:1 ratio is larger. The change of temperature difference between the soils with sandstone: sand=0:1 is small. (Figure 8) The soil with 9 years of soil formation has the highest temperature in sandstone: sand=0:1 in different soil layers, between 31.10 - 35.44°C. Followed by sandstone: sand = 1:1 compound soil (30.95 - 35.11°C), sandstone: sand = 1:2 compound soil (30.82 - 34.44°C), loess: sand = 1:2 compound soil (30.43—33.12°C), sandstone: sand = 1:5 compound soil temperature is the lowest, between 28.64 - 32.03°C. In the 5cm and 20cm soil layers, the temperature difference of the soil in the sandstone: sand=1:1 ratio is larger. In the 10cm and 15cm soil layers, the temperature difference of the soil in the sandstone: sand=1:2 ratio is larger. In the 25cm soil layer, the temperature difference of the soil in the sandstone: sand=1:5 ratio is larger. In the 5-15cm soil layer, the temperature difference of the soil in the sandstone: sand=1:2 ratio is small. (Figure 9)
Figure 8. Diurnal variation of land temperature in two years of soil formation under the same soil layer.
4. Conclusion

(1) The variation of ground temperature in different soil layers of 2 and 9 years of soil formation is $5\text{cm} > 10\text{cm} > 15\text{cm} = 20\text{cm} = 25\text{cm}$. It is expressed that the temperature of the soil in the 9-year-old compounded soil is lower than the temperature of the soil in the compounded soil for 2 years.

(2) The soil with 2 years of soil formation has the highest temperature in sandstone: sand = 1:2 in different soil layers, which is the lowest temperature of compound soil in sandstone: sand = 0:1. In the 9-year-old compounded soil, the loess: sand = 1:2 ratio of the soil in the different soil layers has the lowest temperature, and the sandstone: sand = 1:5 ratio of the soil in different soil layers is better.

(3) During the time period from 8:00 to 20:00, as the measurement time changes, the ground temperature change trend can be fitted by the polynomial equation $y=ax^2+bx+c$. The 5cm soil layer is most obvious. As the depth of the soil increases, the slope of the polynomial curve gradually decreases.

(4) In the 9-year-old soil, the time when the sandstone: sand = 1:1 soil peaked from 14:00 to 16:00, the time when the loess: sand = 1:1 soil peaked from 16:00 to 18:00. The time when other compound soils reach their peak is 16:00.
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