Disciplinarian of soil nutrient in the surface of terrace wall

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Abstract. In loess tableland area, farmers usually collected the soil in the surface of terrace section (or called “terrace wall”) as fertilizer. Actually it contains abundant nitrogen and potassium. As fertilizer, it would be used as new and ecological materials in crop production. In order to analyse the disciplinarian of soil nutrient in the surface of terrace wall, soil samples were divided into three different ages: one year, five years, above ten years; different two slope aspects: sunny- and shady slop; three ground level: 0.2m, 1m, 1.8m above ground; and three vertical depths: 0-1 cm, 1-5 cm, 5-10 cm. The results showed: with the increase of age and ground level, soil nutrients, such as total nitrogen, available phosphorus and potassium were activated and accumulated in the surface of terrace wall under the effect of solar-thermal resources. In the sunny slope, soil nutrients were much higher than those in the shady slope caused by radiation. Soil nutrients were decreased with the increase of sampling vertical depth, most soil nutrients were found in the section surface, which proved soil nutrients were mainly accumulated in the surface of terrace wall.

1. Introduction

As the prerequisites of crop growth, soil provided nutrients and water for plants. Soil quality not only affects the growth and yield of crops, but also restricts the sustainable development of agriculture. To get higher yield, develop ecological agriculture, soil quality must be improved so that the relationship between soil quality and environment should be taken into account [1-3]. In loess tableland, especially in Chengcheng, Pucheng and Xunyi County, farmers usually collected the soil in the surface of terrace section (or called “terrace wall”) as fertilizer. Under the direct effect of radiation, wind and water, soil nutrients will be accumulated in the surface of terrace wall, especially nitrogen and potassium. As fertilizer, it would be used as new and ecological materials in crop production. There are three common approaches to evaluate soil restoration:(1) measure the degree of recovery directly after the disturbance, (2) quantize the recovery process of disturbance, (3) measure indicators that reflect the characteristics of the recovery mechanism [4]. In China, the study of soil quality recovery in China mainly adopts space-time intergenerational method. Selecting plots with different recovery years but similar natural
conditions and management methods in the basin to analyze the changes of soil quality and other indicators in selected land use type. Although this method can't guarantee the external environment is constant, but it can get the evolution rule of the long-term time scale, it is a research method widely used in the study of spatio-temporal evolution in the field of ecology [5]. Bao [6] conducted an experiment to analyze the physical, chemical and biological quality of soil in the Nianzhuanggou and Nihegou River basin. The results showed all nutrients were in a medium or low leve, except for total phosphorus and potassiu. Soil quality indexes of terrace will firstly gradually increase and then slowly decrease likes a wav. Xue[7] chose Zhifang Valley River basin in the loess hilly area as study site, space-time intergenerational method was used. It proved that when terraces be transformed, soil indicators showed different degrees of decline or no significant changes. However, with time goes on, soil quality will significantly increase.

2. Material and method
The trial was carried out in Nanniwan County, Yanan, Shaanxi Province, China. The climate was classified as warm temperate sub-humid continental monsoon climate with adequate radiation. The annual mean temperature is 9.4°C, highest temperature is about 39.7°C in summer and lowest temperature is -25.4°C in winter. The annual mean precipitation is about 556mm. According to different ages, slope aspects, vertical heights and depth, soil samples were collected in 9th Dec. 2017 and divided into three different ages: one year, five years, above ten years; different two slope aspects: sunny slope and shady slop; three vertical heights: 0.2m, 1m, 1.8m above ground; and three vertical depths: 0-1 cm, 1-5 cm, 5-10 cm. After collection, all the soil samples were dried and sieved. The pH value of each soil sample was measured by conductivity, total nitrogen, available phosphorus, available potassium, active organic carbon.

3. Results and analysis

3.1. Distribution of soil nutrients in different age of terrace wall
Soil nutrients in different age of terrace wall were quite different. It is shown in Figure.1 that the relationship between soil conductivity, available phosphorus and formation age were exponential, while the relationship between total nitrogen, available potassium, active organic carbon and formation age were linear. Soil pH was decreased from 8.7 in one-year terrace wall to 8.2 in ten-year terrace wall as time goes on. Soil conductivity, total nitrogen, available phosphorus, available potassium, active organic carbon increased by 267.0%, 120.7%, 188.4%, 98.4%, 373.3% respectively as compared to those in ten-year terrace wall. Under the long time impacts of radiation, temperature and water, soil nutrients in the surface of terrace wall were activated and accumulated.
3.2. **Distribution of soil nutrients in different vertical heights of terrace wall**

The distribution of soil nutrients in different vertical heights of 10-year terrace wall was demonstrated in Figure 2. Soil pH, total nitrogen, available phosphorus, available potassium and active organic carbon increased with the increase of ground level, except for soil conductivity. The conductivity reduced from 1.216 ds/m at 0.2 m above ground to 0.098 ds/m at 1.8 m above ground, soil pH, total nitrogen, available phosphorus, available potassium, active organic carbon at 1.8 m above ground were 7.2%, 70.8%, 46.4%, 193.3%, 175.5% more than those at 0.2 m above ground. Due to the effect of climate factors and leaching, soil nutrients accumulated in the top of terrace wall which are close to tillage layer.
3.3. Distribution of soil nutrients in different slope aspect of terrace wall

The distribution of soil nutrients in different slope aspect of terrace wall showed if solar-thermal resources have effect on terrace wall. All indexes in sunny slope were much higher as compared to those in shady slope, except soil conductivity. Moreover, soil conductivity in sunny slope was 64.6% less than those in shady slope, while soil pH, total nitrogen, available phosphorus, available potassium, active organic carbon were about 3.5%, 8.0%, 19.1%, 37.5%, 46.7% higher, respectively. Solar-thermal resources can accelerate the accumulation of soil nutrients in the surface of terrace wall.

**Figure 2.** Distribution of soil nutrients in different heights of terrace wall
Table 1. Distribution of soil nutrients in different slope aspect of terrace wall

| Slope aspect | pH      | Conductivity (ds/m) | Total nitrogen (g/kg) | Available phosphorus (mg/kg) | Available potassium (mg/kg) | Active organic carbon (g/kg) |
|--------------|---------|---------------------|-----------------------|-------------------------------|-----------------------------|-----------------------------|
| Sunny slope  | 8.8±0.0 | 0.101±0.00          | 0.27±0.03a            | 8.80±0.12a                    | 121±4a                      | 0.22±0.01a                  |
| Shady slope  | 8.5±0.0 | 0.285±0.01          | 0.25±0.02             | 7.39±0.08b                    | 88±3b                       | 0.15±0.01b                  |

3.4. Distribution of soil nutrients in different vertical depth of terrace wall

In cross section with the same high level, soil nutrients in different vertical depths showed significantly different (Figure. 3). Soil conductivity, total nitrogen, available phosphorus, available potassium and active organic carbon decreased with in–depth sampling, except pH. Moreover, soil pH with vertical depth 0-1 cm was 4.6% less than that with vertical depth 5-10 cm, soil conductivity, total nitrogen, available phosphorus, available potassium, active organic carbon with vertical depth 0-1 cm were 241.6%, 80.0%, 22.1%, 104.9%, 73.7% higher than those with vertical depth 5-10 cm. The results illustrated soil nutrients were mainly accumulated in the surface of terrace wall due to the effect of temperature, radiation and water.
4. Conclusion
According to analysis the disciplinarian of soil nutrients in different age, vertical height, slope aspects and vertical depth, we concluded that:

1) With the increase of age, especially above 10 years, soil nutrients will be activated and accumulate in the surface of terrace wall with the effect of climate factors such as temperature, radiation and water.

2) With the increase of vertical heights above ground, soil nutrients in the surface of terrace wall were increased due to the climate effect and leaching.

3) In the sunny slope, soil nutrients were much higher than those in the shady slope, which indicates solar-thermal resources can accelerate the accumulation of soil nutrients in the surface of terrace wall.

4) Soil nutrients were decreased with the increase of sampling vertical depth. Most soil nutrients were found in the section surface, especially the vertical depth 0-1 cm, which proved that soil nutrients were mainly accumulated in the surface of terrace wall.

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