INTERNATIONAL
SOIL AND WATER
CONSERVATION RESEARCH

# Effects of tillage practices on nutrient loss and soybean growth in red-soil slope farmland

Yang Jie[1], Zheng Haijin[2], Chen Xiaoan[3], and Shen Le[4]

**Abstract**

Field experiments were conducted to examine the effect of tillage practices on sediment and nutrient loss and soybean growth under natural rainfall conditions. Three tillage practices were applied: downslope ridge (check), downslope ridge + contour living hedgerow, and cross ridge. Cross ridge tillage reduced surface runoff by 69% and sediment yield by 86%, compared to the check treatment. The downslope ridge with a contour living hedgerow reduced surface runoff by 24% and sediment yield by 53%. Additionally, compared to the check plot, nutrient losses carried by runoff were reduced by over 68% and that carried in the sediment was reduced more than 85% in the cross ridge plot. Nutrient losses in runoff were reduced by 20% to 30% in the downslope ridge and contour living hedgerow plot and those carried in the sediment were reduced by 44% to 57%. Cross ridge tillage soybean yields exceeded those of the downslope ridge and downslope ridge + contour living hedgerow treatments by 16% – 18%. Cross ridge tillage could contribute to the prevention sediment and nutrient loss and could improve crop yield, and thus it is recommended to be applied to mild slopes in the red soil region.

**Key Words**: Red soil, Slope farmland, Tillage practices, Nutrient loss, Crop growth

## 1 Introduction

Sloping farmland is an important resource, and also a major source of soil and water loss in China. In recent years, with the increased use of sloping farmland and chemical fertilizer, soil and water loss and non-point source pollution on sloping farmland caused by agricultural activities are gradually coming into focus (Quan & Yan, 2002; Zhu et al., 2005). In-depth systematic studies of the effect of tillage practices on soil erosion, nutrient loss, and crop growth under natural rainfall conditions could not only provide technical support for soil and nutrient loss control and agricultural non-point source pollution control and prevention, but also offer a theoretical basis to the forecast of land productivity and crop yields, which is of great significance.

There have been a large number of studies on soil erosion and non-point source pollution on sloping farmland in terms of characteristics of runoff and sediment yield, law and influencing factors of nutrient loss, and control and prevention measures of soil erosion and water loss (Guo et al., 2010; Lin et al., 2010; Zhao et al., 2004; Lin et al., 2007; Li et al., 2003; Wang et al., 2010; Huang et al., 2007; Wang et al., 2010; Luo et al., 2007), but

[1] Professorate Senior Engineer, Jiangxi Institute of Soil and Water Conservation, Jiangxi Provincial Key Laboratory of Soil Erosion and Prevention, Nanchang, China. Corresponding author: E-mail: zljyj@126.com

[2] Senior Engineer, [3,4] Junior Engineer, Jiangxi Institute of Soil and Water Conservation, Jiangxi Provincial Key Laboratory of Soil Erosion and Prevention, Nanchang, China

studies on the impacts of different tillage practices on nutrient loss and crop growth on sloping farmland of red soil is still relatively rare. Crops are mainly soybeans, peanuts and other cash crops on the red-soil sloping farmland in Jiangxi Province, China. For this study, standard runoff plots were built on red-soil sloping farmland in Jiangxi Province where soybeans were planted, and agricultural management was carried out fully in accordance with the practices of local farmers. Surface runoff, sediment loss, nutrient loss and crop growth were measured on plots with different tillage practices to provide a scientific basis to guide the development and use of red soil sloping lands and to provide information useful for the control and prevention of agricultural non-point source pollution in the red-soil region in southern China.

## 2 Research methodology

### 2.1 *Site description*

The study site was in Jiangxi Ecological Science and Technology Park of Soil and Water Conservation. The science and technology park is located in the Yangou Watershed of the Poyang Lake Basin, in De'an County of northern Jiangxi Province, China (115°42′38″–115°43′06″E, and 29°16′37″–29°17′40″N). The site is in the subtropical monsoon climate zone. The mean annual rainfall is 1,350 mm. The mean annual temperature is about 17℃. The annual sunshine duration is 1,650 to 2,100 hours. The average annual frost-free period is 249 days. The landform is low hills, with an altitude of 30 to 100 m, slope of 5° to 25°. The soil parent materials are primarily Quaternary red clay, and the zonal vegetation is subtropical evergreen broadleaf forest. This park is situated in the center of red soil in China, the topography and soil conditions of which are representative of Jiangxi Province and the red-soil region of southern China.

### 2.2 *Experiment design*

Nine standard runoff plots with a slope of 10°, were installed on the same slope where soil thickness, physical and chemical characteristics and slope grades are relatively uniform. Each plot was 100 $m^2$ in size (20 m×5 m). To prevent surface runoff from flowing into and out of the plots, each plot was surrounded by a 12 cm thick boundary ridging made of concrete bricks, 20 cm above the surface and 30 cm underground. There were rectangular collecting channels and circular collecting tanks below each plot to collect runoff and sediment. Three collecting tanks were designed for each plot, namely A, B and C, according to the local maximum 24-hour storm and runoff volume once in 50 years that may occur. They were made of stainless steel, 1 m in diameter and 1.2 m in height, and the water inlets were 1 m high. Tank A and B had 5 circular flow-dividing holes around the tank walls by "five-group" method, and four groups of contents in tank A were discharged and one group flowed into tank B; like A, four groups of contents in tank B were discharged and one group flowed into tank C. The flow-dividing holes were all 0.8 m high. Each tank was calibrated. Gauges were stuck on the tank walls to observe the water level. In order to facilitate runoff discharge, a circular hole with a diameter of 10 cm and a rubber valve were set on the bottom of each tank.

According to the common local management mode of soybean planting on slope farmland, three treatments, each with 3 replications, were randomly located on the slope. Soybeans were planted on June 18, 2011 and harvested on October 3, 2011 on each plot except control plot (nudation plot). Experimental treatments and design are elaborated in Table 1.

**Table 1** **Treatments and design of the experiment**

| Treatment number | Tillage | Descriptions |
|---|---|---|
| I | downslope ridge (control) | Ridge width was 70 cm, and height was 30 cm. Soybeans were planted with 20 cm of spacing in the rows and 35 cm of spacing between the rows on the ridge. Downslope ridge tillage was the tillage practice. |