Effects of different economic fruit forests on soil nutrients in Qingxi small watershed

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Abstract: Taking Qingxi small watershed in Hanyuan County of Ya’an City as an example, the effects of four different economic fruit forests on the sloping farmland in the dry-hot valley region on the soil nutrient loss before and after the flood season were studied. The results showed that after the flood season, the soil Organic matter (OM) content of the four economic fruit forests increased, which was characterized by large cherry forest > peach forest > pear forest > pepper forest, but no crop cultivated land decreased. Alkali nitrogen (AN) and Available phosphorus (AP) of four economic fruit forests decreased, but the degree of declining was lower than that of cropless cultivated land. The Total nitrogen (TN) content of the soil of the cherry forest and peach forest decreased, but the degree of declining was lower than that of the cropless cultivated land, while the pear and pepper forests increased. The large cherry forest and pepper forest content of Total phosphorus (TP) in the soil was reduced, while the peach and pear forests increased. In terms of OM, large cherries are the best choice for local fruit forest. Pear trees are the best choice for the change of N or P elements. From the comprehensive analysis of soil nutrient changes, pear trees are the best fruit forest in the region.

1. Introduction
Diffused Pollutio, or non-point source pollution. Diffused Pollutio are mainly derived from soil erosion, excessive use of fertilizers and pesticides, urban and public path flows, livestock and poultry farming and rural waste [1]. The wide range of Diffused Pollutio and the high degree of damage have become the main cause of deterioration of water quality. Soil erosion can cause serious Diffused Pollutio.

The comprehensive management of small watersheds combines engineering measures, biological measures and soil cultivation to control the source system and transfer route of Diffused Pollutio. In the comprehensive management of small watersheds, planting fruit forests on sloping farmland is a suitable biological measure. It can not only maintain water and soil, reduce the loss of soil nutrients, reduce Diffused Pollutio, but also develop economy.

At present, there are few studies on the prevention and control of Diffused Pollutio in the
comprehensive management of small watersheds. The related research mostly evaluates the benefits of treatment [2-4], the effects of different vegetation cover on soil nutrients [5-7], and Diffused Pollutio intensity monitoring [8], single soil nutrient loss study [9-11], etc. research methods are mostly based on indoor or outdoor simulation studies [12]. There are few reports on the effects of different fruit forest on soil nutrients under natural conditions on sloping farmland. Qingxi Small Watershed in Hanyuan County of Ya’an is a typical small watershed in the dry-hot valley area. It is a demonstration base for comprehensive management of small watersheds in Sichuan Province. It is very representative in terms of scale and efficiency of soil and water conservation. In view of this, this paper takes the Qingxi small watershed as the research object, and explores the influence law of different fruit forest on the soil nutrient loss in the sloping farmland in the dry-hot valley area, in order to reveal the prevention and control effects and changes of the Diffused Pollutio of different fruit forest. Therefore, it provides some basic data for the comprehensive management planning and design of small watersheds, and provides some reference for the research on prevention and control of Diffused Pollutio of soil erosion, and provides some guidance for agricultural production management.

2. Materials and methods

2.1. Research area overview
Qingxi Town is located 39 km north of Hanyuan County. It is an alpine valley in the southwestern part of the Daxiangling Mountains. It belongs to the middle of the Dadu River and is a subtropical dry-hot valley with less rain. The evaporation is greater than the rainfall, and the rainfall is less and the spatial and temporal distribution is uneven. Rainfall is concentrated from May to October, especially in July and August. The dry-hot valley has the characteristics of abundant light and heat resources, dry and hot climate, low vegetation coverage, serious soil erosion, strong ecological environment degradation and difficult vegetation restoration et al.

The Qingxi Small Watershed soil and water loss control project began construction in 2014. The sloping farmland mainly adopts the treatment method of fruit forest. The fruit forest are mostly four types: pepper, large cherry, peach and pear.

2.2 Soil sample collection
Select four representative fruit forest on the local slope farmland: pepper forest, large cherry forest, peach forest, pear forest, and three sample plots of 10 m × 10 m in each plant type, so that each type has three repeated, and use the cropless cultivated land on the local slope farmland as a contrast (CK). Each sample was sampled by the S-sampling method before the May 2017 flood season and after the October flood season. The soil depth was 0-20 cm and Each soil sample weighs approximately 500 g.

After the soil sample to be recovered is naturally air-dried, it is ground and sieved, and then the soil OM, AN, TN, AP and TP are measured.

2.3 Measurement items and methods
The OM was determined by potassium dichromate method, the AN was determined by alkali diffusion method, the TN was determined by Kjeldahl method. Determination of AP and TP by molybdenum colorimetry [13].

2.4 Data processing and analysis
Data processing and statistical analysis using Excel 2007 and SPSS 13.0.

3. Results and analysis

3.1 Effects of different fruit forest on soil OM content
It can be seen from Table 1 that except for the pear forest after the flood season, the OM content of several fruit forest in the soil before and after the flood season is significantly lower than that of the
cropless cultivated land. The reason may be that the crop absorbs the nutrients in the soil humus during the growth and development process.

On the sloping land without crops, the soil OM content decreased by 32.3%, while the soil OM of the four fruit forest increased in different degrees, and the large cherry forest increased the most. It can be seen that planting fruit forest on sloping farmland has a significant effect on improving the OM content of soil, and the promotion of large cherry forest is the largest.

### Table 1. Soil OM content in different fruit forest.

| Types            | Before the flood season (%) | After the flood season (%) | Increase (%) |
|------------------|-----------------------------|----------------------------|--------------|
| Pepper forest    | 3.40±0.13c                  | 3.63±0.28b                 | 6.95         |
| Large cherry forest | 3.49±0.25c                 | 5.59±0.53ab               | 60.3        |
| Peach forest     | 3.83±0.19c                  | 5.19±0.34ab               | 35.5        |
| Pear forest      | 7.34±0.45b                  | 8.11±0.67a                | 10.4        |
| No crop (CK)     | 10.4±0.14a                  | 7.05±0.61ab               | -32.3       |

Note: Different lowercase letters indicate that the mean difference between treatments is significant (P<0.05), the same below

#### 3.2 Effects of different fruit trees on soil TN content

It can be seen from Table 2 that except for the pear forest after the flood season, the TN content of the other types of soil is significantly lower than that of the cropless cultivated land before and after the flood season, which may be due to the absorption of N elements in the soil during plant growth and development.

After the flood season, the TN content of the cropless cultivated land, the large cherry forest, and the peach forest decreased, and the cropless land has the largest decline. The pepper forest and pear forest have increased, and the pepper forest has the largest increase. It can be seen that the fruit forest can reduce the loss of TN in the soil and even increase the TN content of the soil, thereby enhancing the soil nutrient supply capacity. On the whole, the TN content of the soil of the pepper forest increased the most.

### Table 2. TN content in different fruit forest.

| Types            | Before the flood season (%) | After the flood season (%) | Increase (%) |
|------------------|-----------------------------|----------------------------|--------------|
| Pepper forest    | 367±7.80c                   | 448±35.9c                  | 22.0         |
| Large cherry forest | 622±39.1bc                 | 562±38.9c                 | -9.69        |
| Peach forest     | 674±20.0b                   | 641±15.3c                 | -4.92        |
| Pear forest      | 1.70×10³±152a               | 1.77×10³±142a             | 3.89         |
| No crop (CK)     | 1.90×10³±12.7a              | 1.39×10³±126b             | -27.0        |

#### 3.3 Effects of different fruit forest on soil AN content

It can be seen from Table 3 that except for the pear forest after the flood season, the AN content of the soils of other forest species is significantly lower than that of the cropless cultivated land before and after the flood season, which may be due to the absorption of N elements in the soil during plant growth and development.

The contents of soil AN in the five types of sloping farmland decreased significantly after the flood season, but the decline of fruit forest is smaller than that of no crop arable land. It can be seen that the four fruit forest can reduce the loss of soil AN and enhance soil nutrient supply capacity. On the whole, the decline of pear forests is the smallest after the flood season.

### Table 3. Soil AN content in different fruit forest.

| Types            | Before the flood season (%) | After the flood season (%) | Increase (%) |
|------------------|-----------------------------|----------------------------|--------------|
| Pepper forest    | 97.7±8.88a                  | 22.6±1.70b                | -76.9        |
Large cherry forest 107±8.69a 26.1±0.31b -75.7
Peach forest 118±11.1a 31.2±0.96b -73.6
Pear forest 188±15.4a 49.7±2.15a -73.5
No crop (CK) 196±3.78a 40.2±2.44a -79.5

3.4 Effects of different fruit forest on soil AP content
It can be seen from Table 4 that except for the pear forest after the flood season, the content of AP in the other three types of soil is significantly lower than that of the cropless cultivated land before and after the flood season, which may be caused by the growth of the crop to absorb the P element in the soil.

After the flood season, the content of AP in the five types of sloping farmland soils decreased significantly. The decline of the four fruit forest is lower than that of the cropless arable land. It can be seen that planting the fruit forest can reduce the loss of soil AP. Among them, the pear forest has the smallest decrease.

Table 4. Soil AP content in different fruit forest.

| Types               | Before the flood season (%) | After the flood season (%) | Increase (%) |
|---------------------|-----------------------------|----------------------------|--------------|
| Pepper forest       | 75.8±3.99b                  | 25.6±1.66b                 | -66.2        |
| Large cherry forest | 73.9±1.97b                  | 18.7±0.97b                 | -74.7        |
| Peach forest        | 96.2±6.95b                  | 52.9±3.50b                 | -45.0        |
| Pear forest         | 387±12.9a                   | 270±19.31a                 | -30.2        |
| No crop (CK)        | 380±12.2a                   | 65.7±0.95b                 | -82.7        |

3.5 Effects of different fruit forest on soil TP content
It can be seen from Table 5 that except for the pear forest before and after the flood season, the TP content of the other three types of soil is significantly lower than that of the cropless cultivated land before and after the flood season, which may be caused by the growth of the crop and the absorption of P in the soil.

In the five types of sloping farmland soils after flood season, the soil TP content increased and decreased, the peach forest and pear forest increased, the pear tree increased the most, and the other three types decreased.

Table 5. TP content in soils of different fruit forest.

| Types               | Before the flood season (%) | After the flood season (%) | Increase (%) |
|---------------------|-----------------------------|----------------------------|--------------|
| Pepper forest       | 891±13.2d                   | 844±19.3c                  | -5.24        |
| Large cherry forest | 934±11.6d                   | 504±13.2bc                 | -46.1        |
| Peach forest        | 1.09×10³±19.2c              | 1.25×10³±34.4b             | 15.0         |
| Pear forest         | 1.65×10³±56.6a              | 3.35×10³±253a              | 103          |
| No crop (CK)        | 1.46×10³±35.4b              | 1.43×10³±133b              | -2.02        |

4. Discuss
Yang Min [14] et al took Wushan County, Chongqing as an example to explore the impact of different land use patterns on soil nutrients, found that soil OM and TN content from high to low in order were wasteland, forest grassland, arable land, fruit forest. The order of AP from high to low was arable land, wasteland, fruit forest, forest grassland. In this study, the soil nutrient content of the fruit forest before and after the flood season was lower than that of the farmland, and the change law was similar to that of Yang Min et al.

Wandan [15] made a related study on the loss of nitrogen and phosphorus under different utilization modes of purple soil. The results showed that the amount of nitrogen and phosphorus nutrient loss per unit area after rainfall was basically the same: slope farmland > wasteland > fruit forest > terrace land.
This is basically consistent with the results of this experiment, and the fruit forest could effectively reduced the loss of nitrogen and phosphorus in the soil.

Liu Peijing [7] analyzed the changes of soil nutrient contents before and after the rainy season in the three land use types of grassland, woodland and sloping land in the Naneng small watershed of Yuanmou dry-hot valley. The results showed that the contents of TN, AN and AP increased, and the TP content decreased. The laws found in this study were not consistent with these results. In this study, the contents of TN and TP in the soil under four fruit forest increased and decreased after the flood season, and the contents of AP and AN decreased after the flood season. These differences may be due to vegetation, elevation, control measures, or human fertilization activities.

One of the reasons for the fact that TP and TN did not show particularly obvious regularity in this study may be caused by human activity factors. The fruit trees in the test area were all scaled planting modes, and fertilization was inevitable during the growth of fruit trees. However, the laws of OM, AP and AN were very significant.

5. In conclusion
Except for pear forests, soil OM, AN, TN, AP and TP in other fruit trees were significantly lower than those non-crop farmland before and after flood season, which may be due to the growth and utilization of crops. Pear trees had not shown obvious regular changes that may be related to artificial fertilization activities.

Large cherry forest had the best effect on increasing soil OM. Compared with the non-crop farmland, the four fruit trees could effectively reduce the loss of soil N and P nutrients, and the pear tree had the best effect.

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