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Effects of Rainfall and Topography on Total Phosphorus Loss from Purple Soil under Simulated Rainfall Conditions

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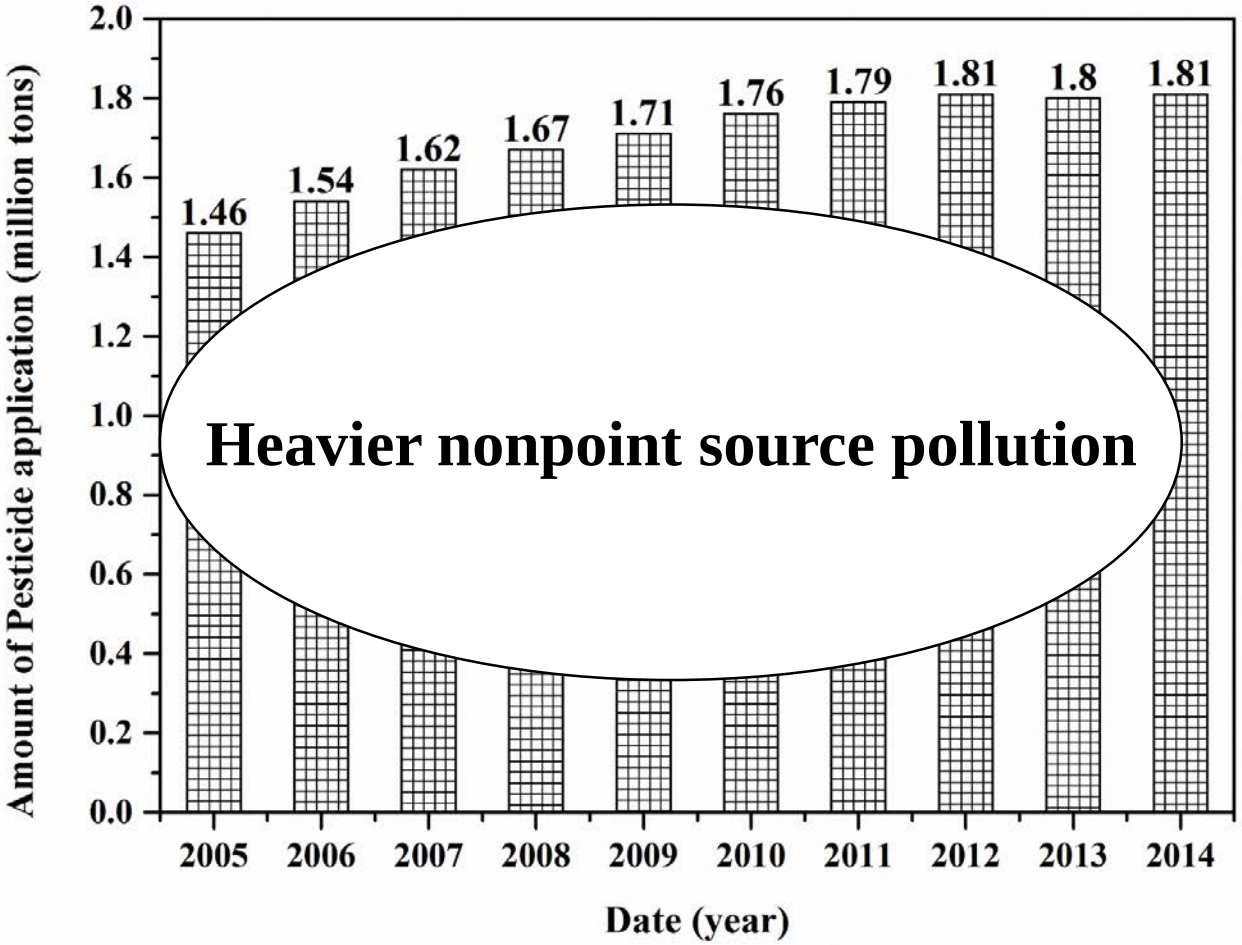
PART 1

Importance

Importance



Amount of Pesticide application in past decade

Importance

Purple soil is an important kind of unirrigated tilth soil and accounting for 68% of the total cultivated area in Sichuan Basin of China.

Importance

Properties of purple soil

- Rich in phosphorus, potassium, and other nutrients
- Fast soil erosion and fast weathering
- Shallow soil

Easily eroded

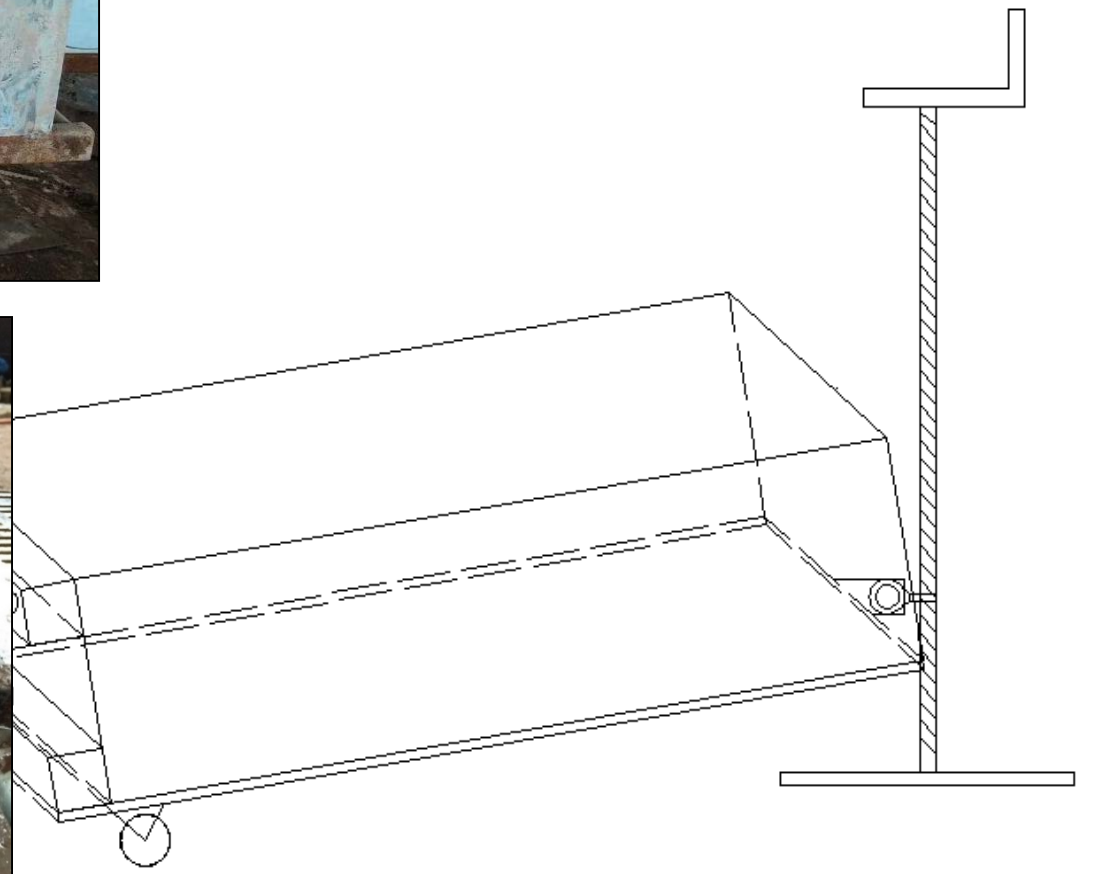
PART 2

Materials

Experiment device
Experiment design

Experiment device

- Soil box for experiment

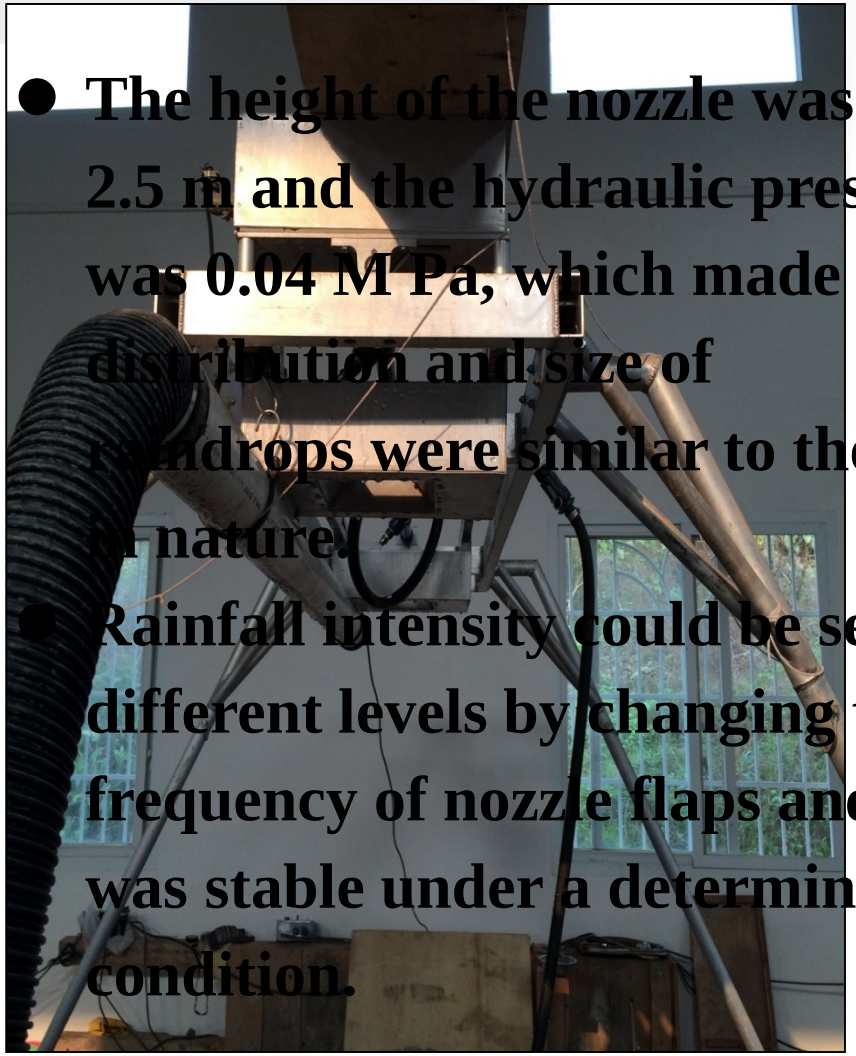


1.0×0.6×0.25 m
Two wheels
Apertures at the bottom of box
Extended 0.1 m
Set a groove with small holes
A regulating screw

Photos were took in January 2015.

Experiment device

- **Norton nozzle-type rainfall simulator**



- **The height of the nozzle was 2.5 m and the hydraulic pressure was 0.04 M Pa, which made the distribution and size of raindrops were similar to those in nature.**
- **Rainfall intensity could be set in different levels by changing the frequency of nozzle flaps and was stable under a determined condition.**

Photos were took in January 2015.

Experiment design

Pretreatment steps

- Passed by a 7-mm sieve to avoid sticky soil jammed meshes
- Air-dried to make water content rate of soil reduced to about 12%
- Mixed thoroughly

- Physical and chemical properties

Soil layers (cm)	Unit weight ($g\ cm^{-3}$)	Initial water content (%)	Organic matter ($g\ kg^{-1}$)	TN ($g\ kg^{-1}$)	TP ($g\ kg^{-1}$)
0-20	1.30	12.16	8.75	0.76	0.68

Experiment design

Process procedure before experiment

Five 5-cm layers of soil were compacted in a soil box to prevent the soil stratification, and the surface of the lower soil layer was loosed before the upper soil layer was filled in.

Experiment design

Designed scenarios for experiment

Slope (A) \ Rainfall Intensity (B)	30 mm h^{-1}	60 mm h^{-1}	90 mm h^{-1}	120 mm h^{-1}
5°	A1B1	A1B2	A1B3	A1B4
10°	A2B1	A2B2	A2B3	A2B4
15°	A3B1	A3B2	A3B3	A3B4
20°	A4B1	A4B2	A4B3	A4B4
25°	A5B1	A5B2	A5B3	A5B4

PART 3

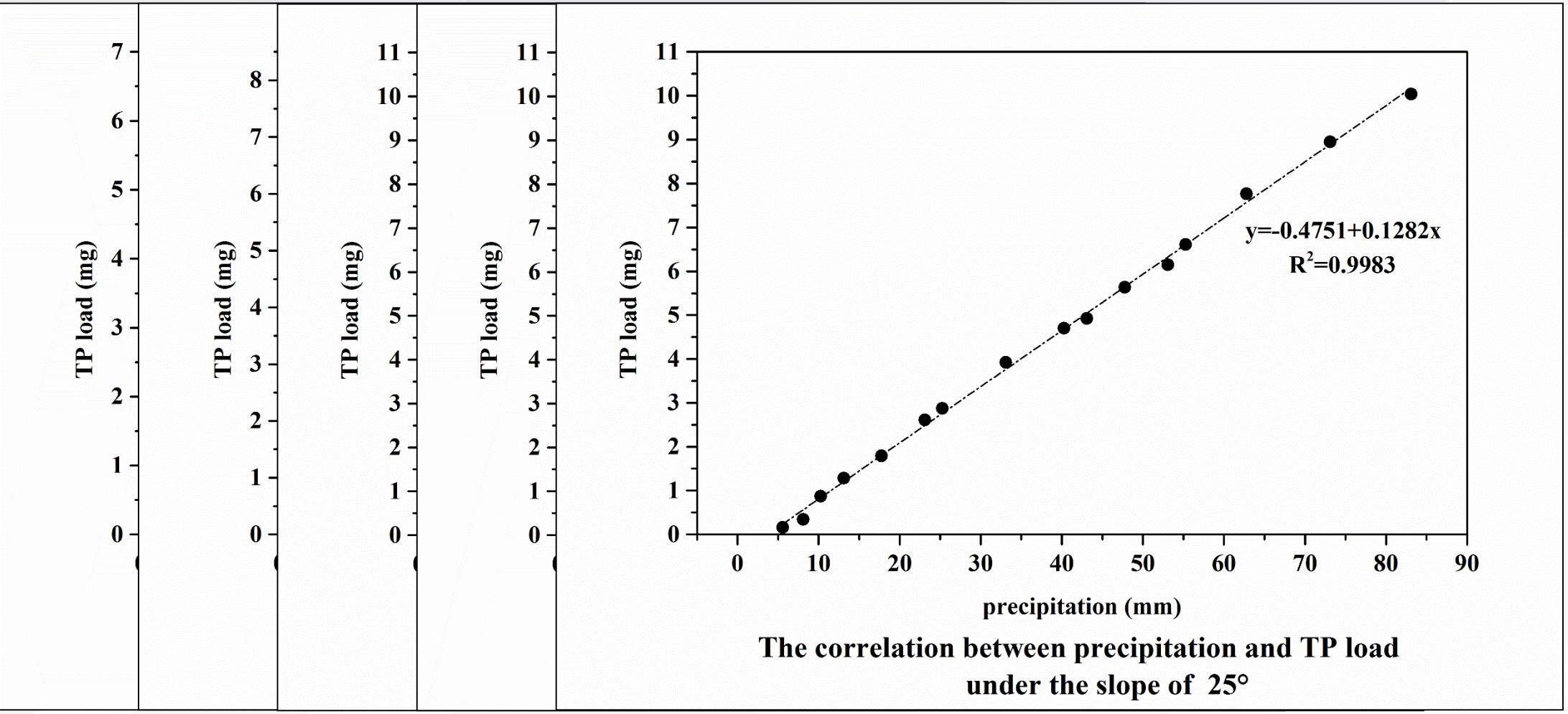
Analysis and discussion

Effects of precipitation on TP loss

Effects of rainfall intensity on TP loss

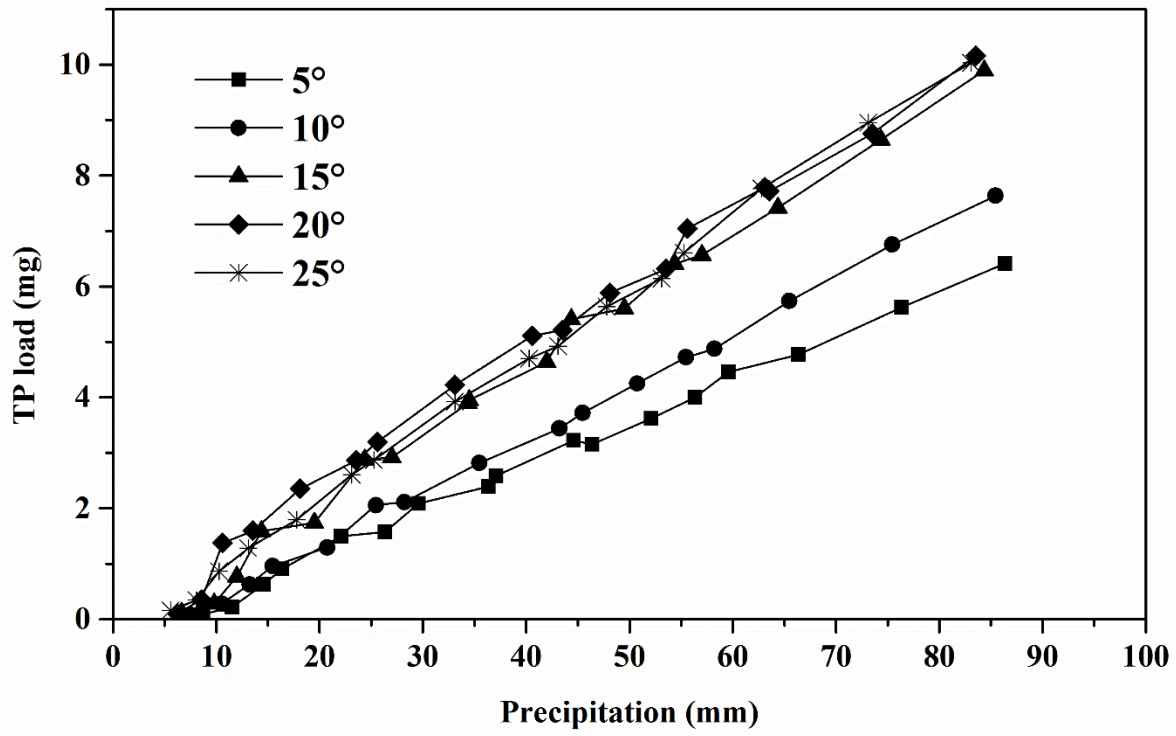
Effects of slope on TP loss

1) Effects of precipitation on TP loss--load



The correlation between precipitation and TP load under the slope of 25°

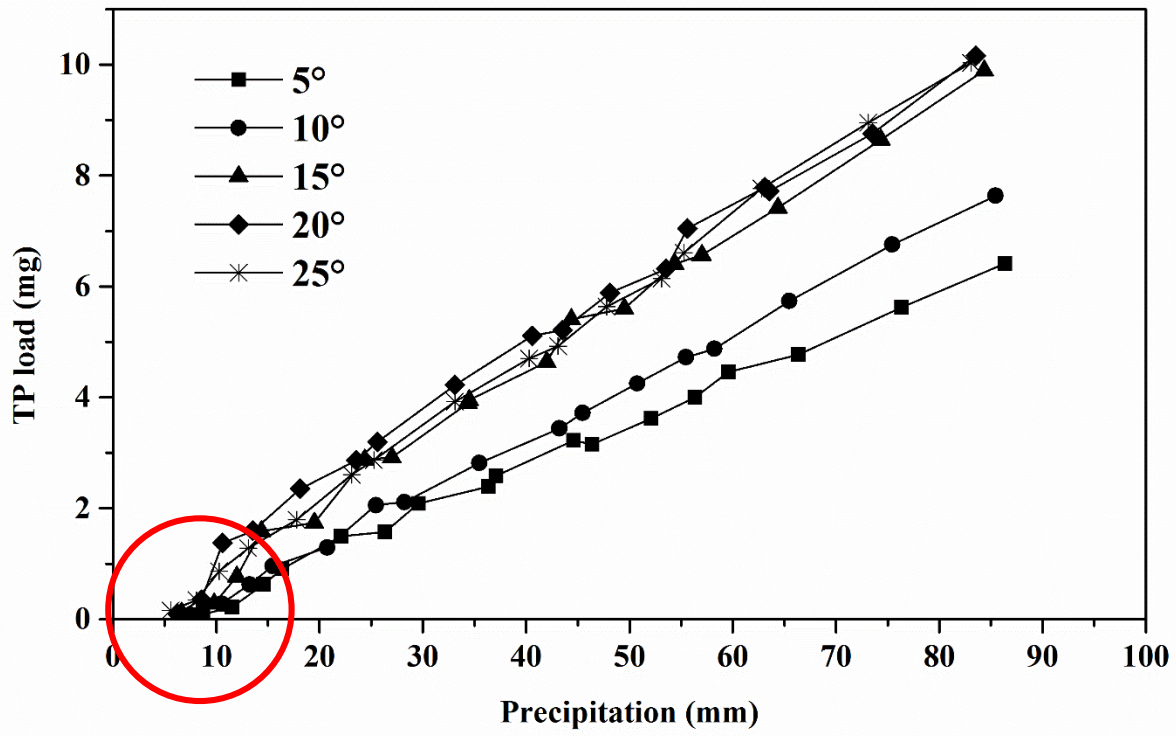
1) Effects of precipitation on TP loss--load



The correlation between precipitation and TP load

- The total phosphorus load was increased with the increase of precipitation at each slope.
- It could be explained that the more the precipitation fell, the larger amount of rainfall runoff and the eroded soil increased, and the more the TP was carried.

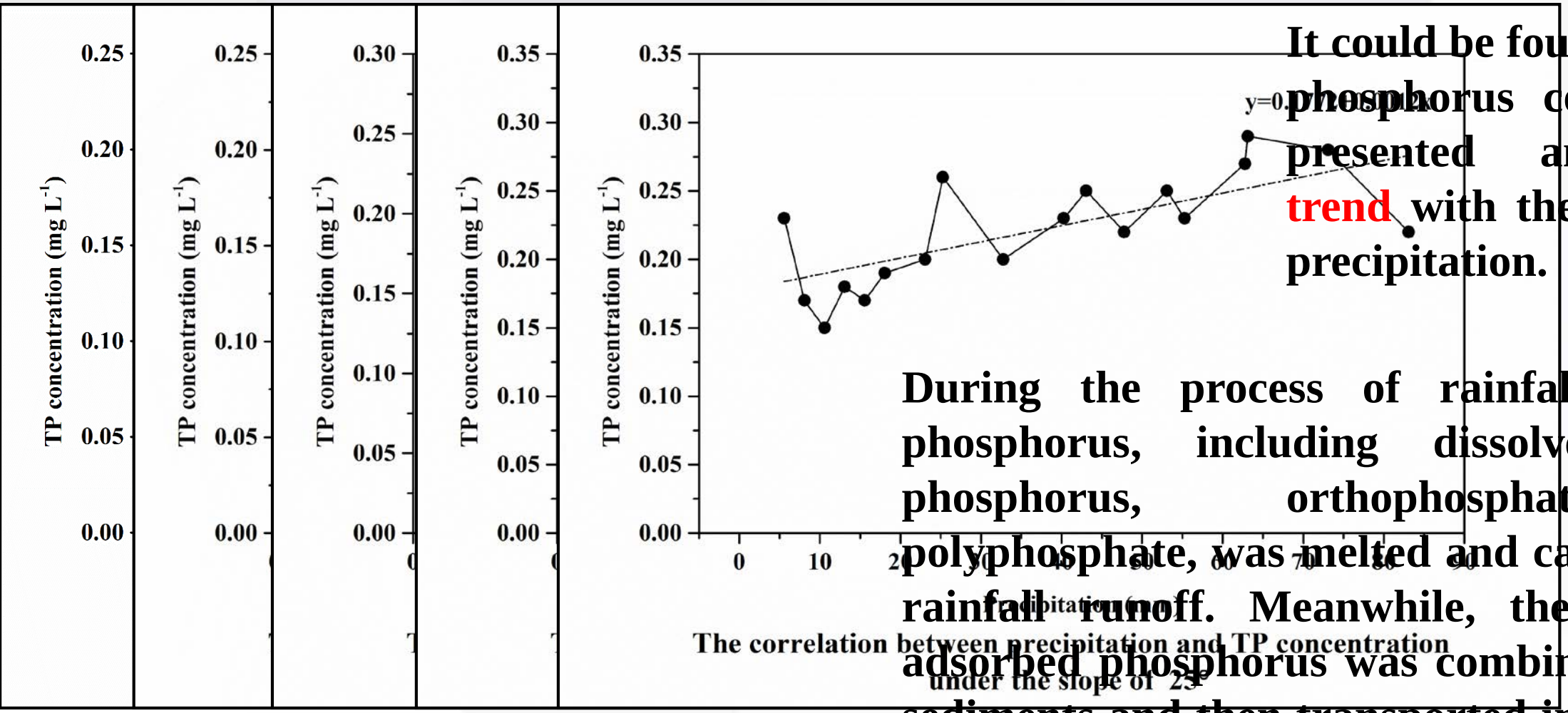
1) Effects of precipitation on TP loss--load



The correlation between precipitation and TP load

- An initial runoff-yielding time could be found before runoff generation in this figure.
- The water content rate was relatively low at the beginning of rainfall. With the increase of precipitation, the infiltration effect led the water content to saturation, the runoff formed, and the TP began to loss by washing and carrying of rainfall runoff as well as soil erosion.

2) Effects of precipitation on TP loss--concentration

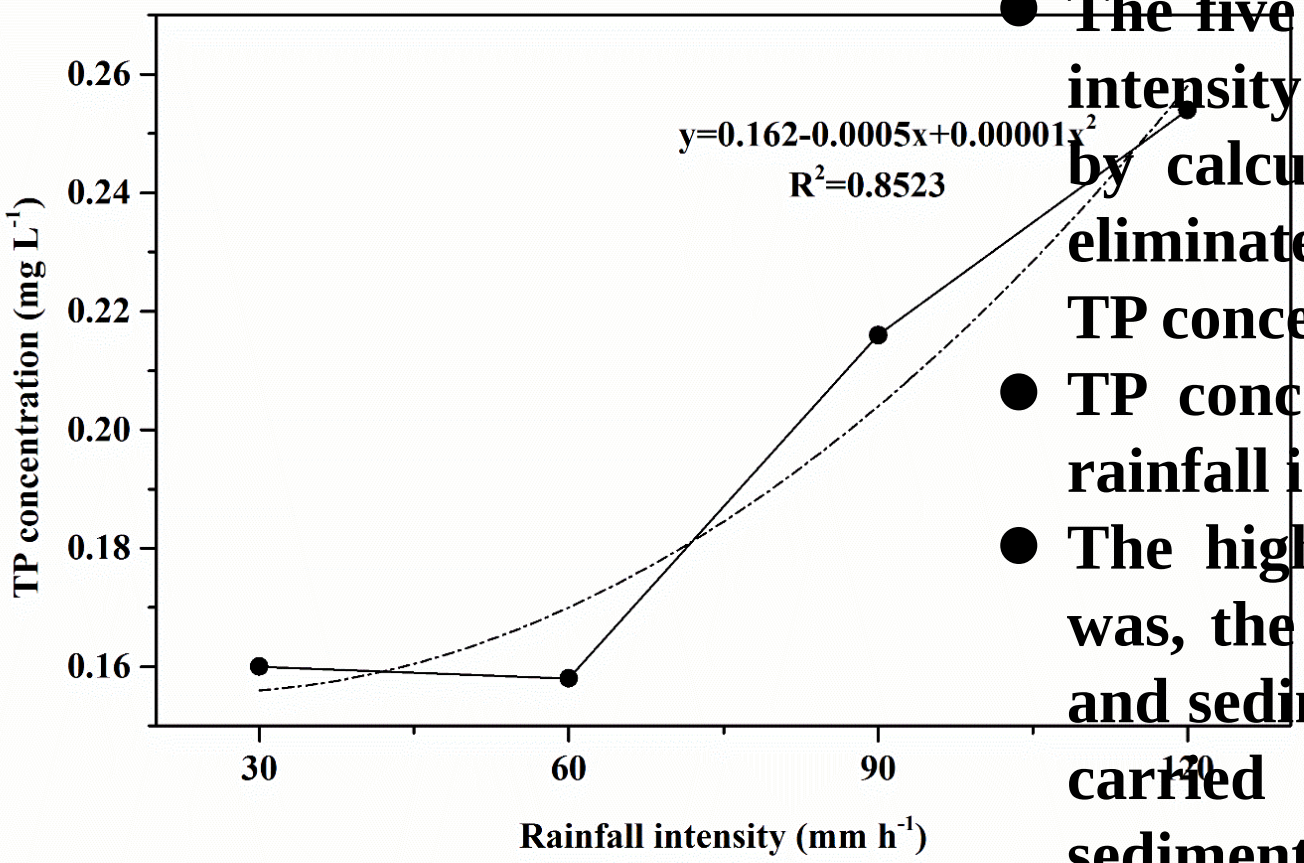


The correlation between precipitation and TP concentration under the slope of 25°

It could be found that total phosphorus concentration presented an increase trend with the increase of precipitation.

During the process of rainfall, dissolved phosphorus, including dissolved organic phosphorus, orthophosphate and polyphosphate, was melted and carried by the rainfall runoff. Meanwhile, the more was adsorbed phosphorus was combined with soil sediments and then transported in the process of water and soil loss.

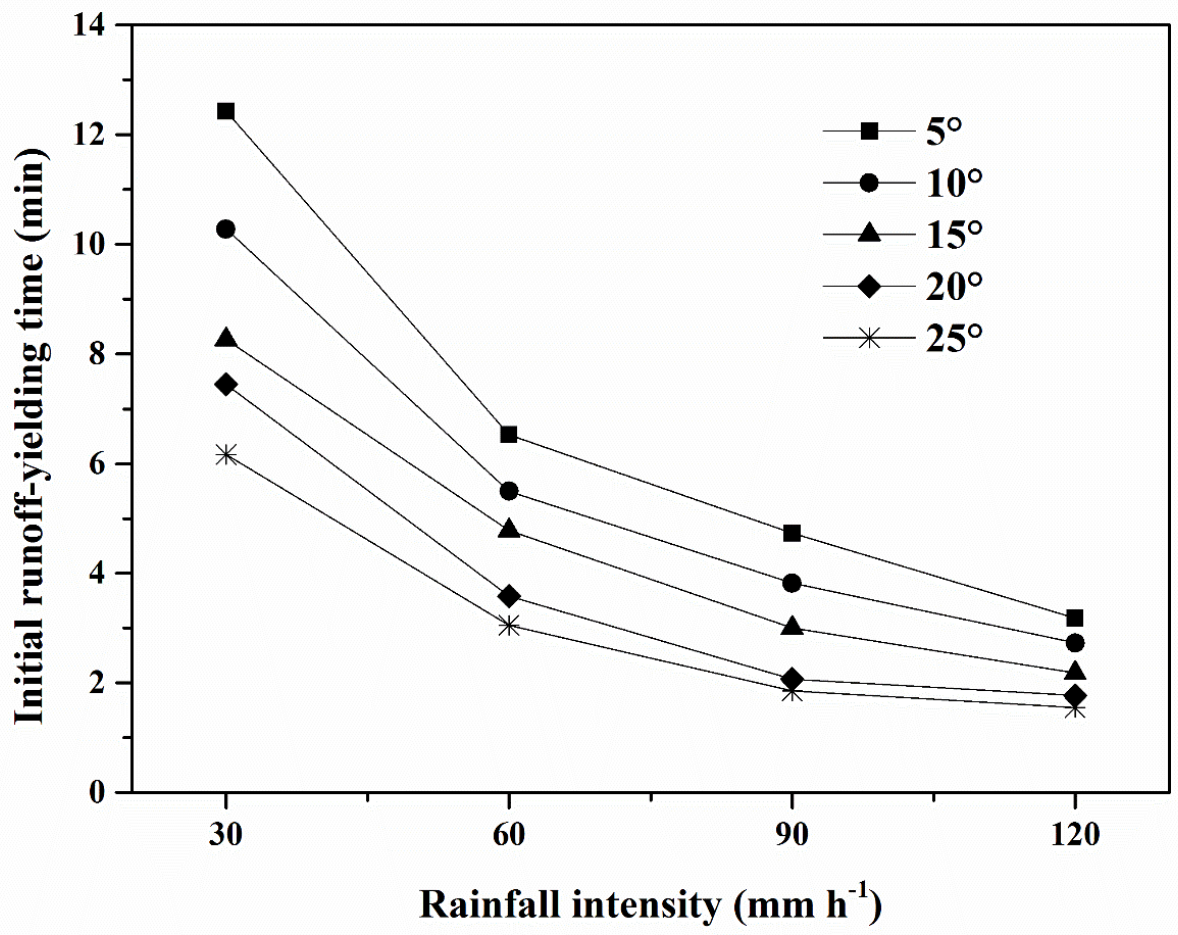
3) Effects of rainfall intensity on TP loss--concentration



The correlation between rainfall intensity and TP concentration

- The five slopes in certain rainfall intensity were integrated as value by calculating mean in order to eliminate the influence of slope on TP concentration in this figure.
- TP concentration rose when the rainfall intensity increased.
- The higher the rainfall intensity was, the more the rainfall runoff and sediments transported, which carried more TP adsorbed on sediments and made the concentration increased.

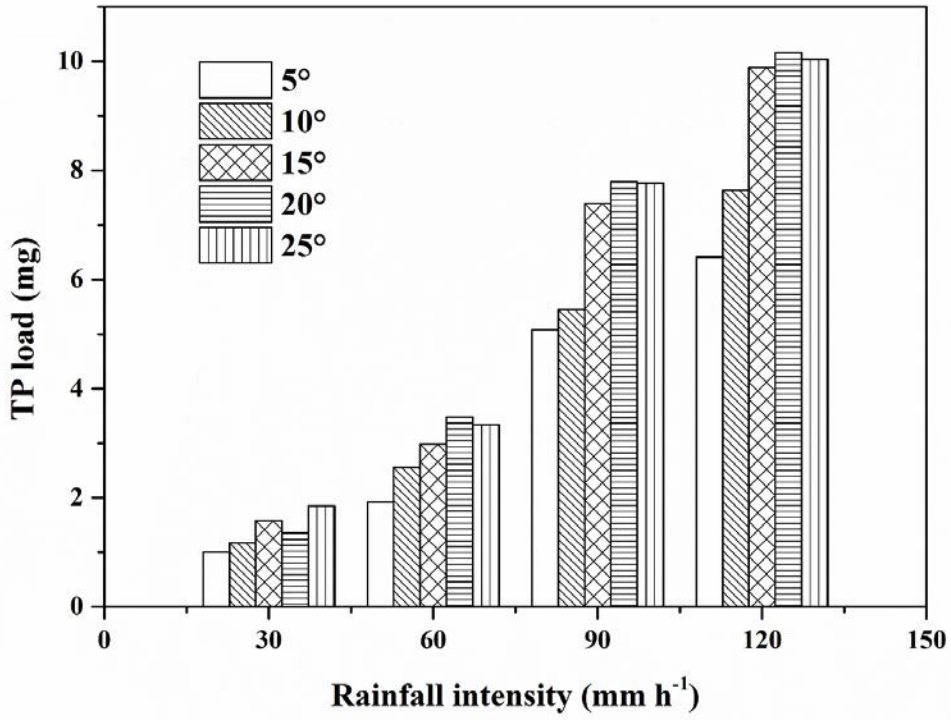
4) Effects of rainfall intensity on initial runoff-yielding time



The correlation between rainfall intensity and initail runoff-yielding time

- The relationship between rainfall intensity and the initial runoff-yielding time was a negative correlation.
- The difference of slopes reduced as the rainfall intensity increased which stood for rainfall intensity played a more and more important role in affecting the initial runoff-yielding time with the rise of rainfall intensity.

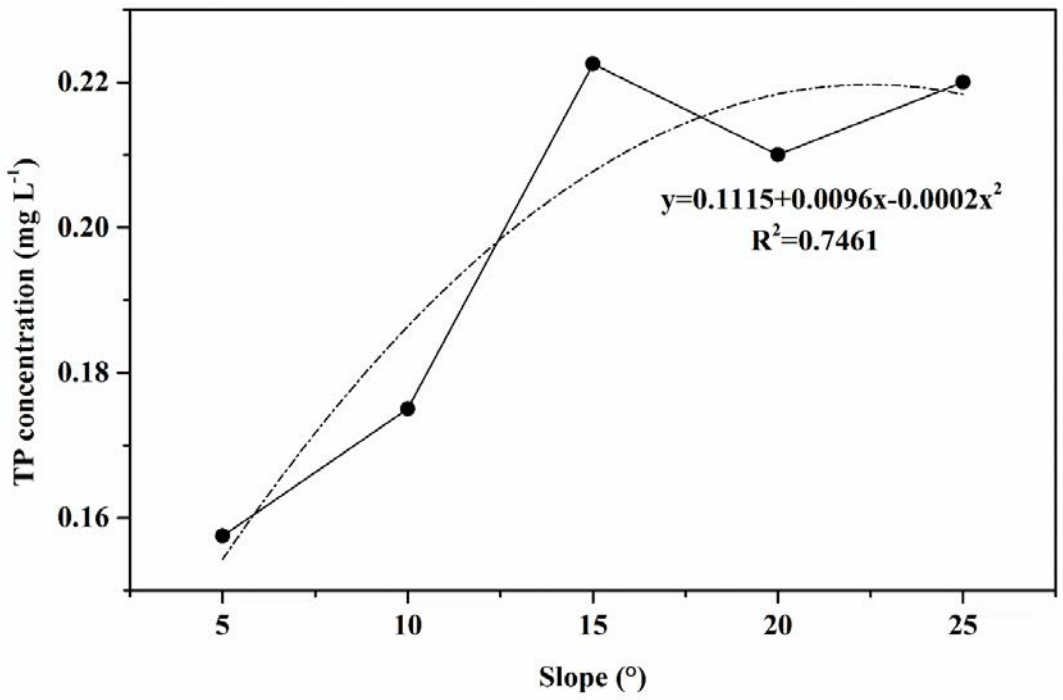
5) Effects of slope on TP loss--load



The correlation between slope and TP load under various rainfall intensities

- When slope increased, TP load grew generally under various rainfall intensity conditions.
- It could be explained that the effect of scouring was more powerful at steeper slopes, a larger amount of rainfall runoff would generated, more sediments would be carried, and more serious TP loss occurred.

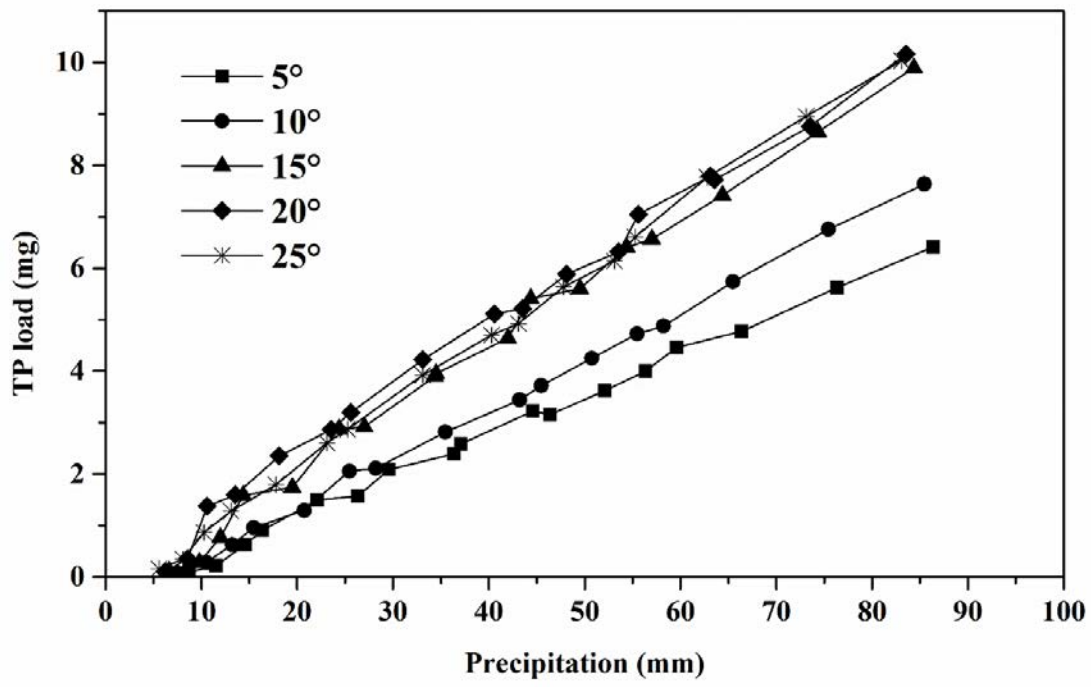
6) Effects of slope on TP loss--concentration



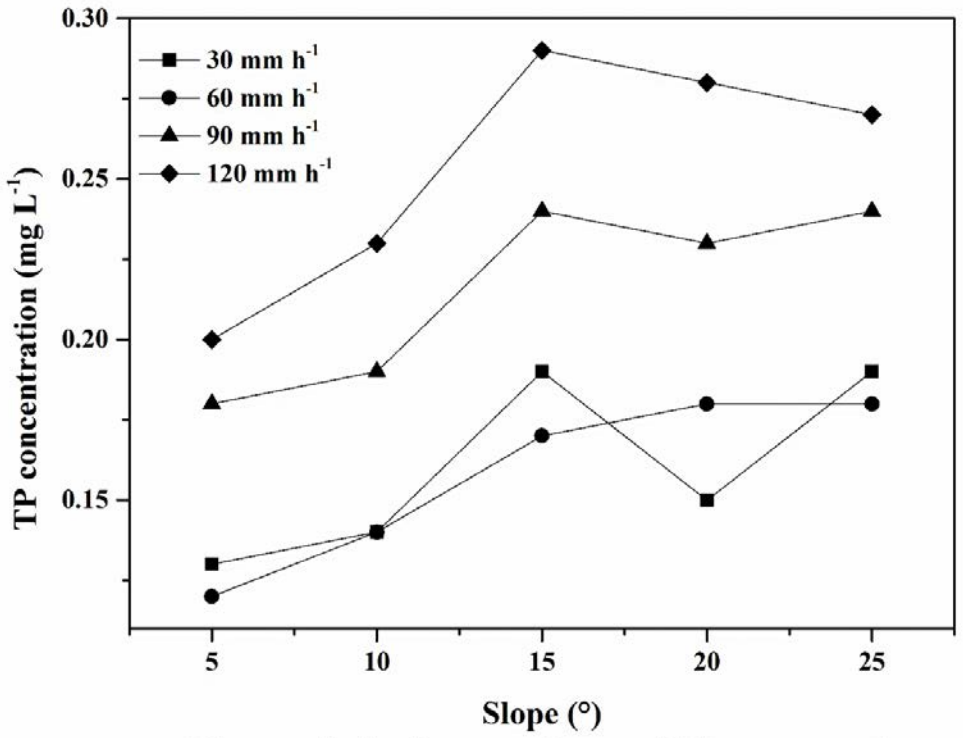
The correlation between slope and TP concentration

- Five rainfall intensities in certain slope were integrated an average value, in order to ignore the influence of rainfall intensity on TP concentration.
- TP concentration showed a positive correlation with the increase of slope before degree 15, and then TP concentration decreased with the increase of slope.

6) Effects of slope on TP loss--concentration



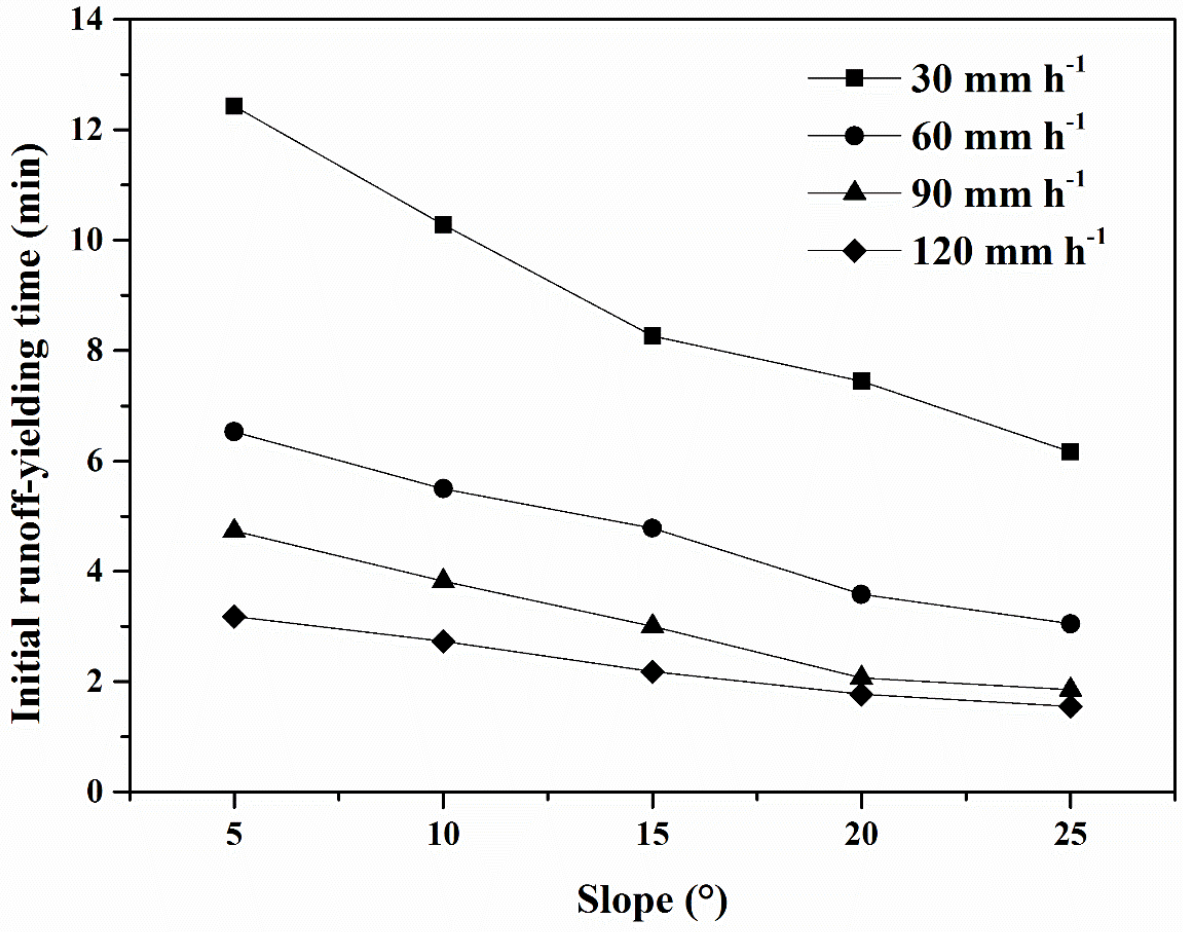
The correlation between precipitation and TP load



The correlation between slope and TP concentration under various rainfall intensities

There was a critical slope of TP loss and the critical slope was degree 15 in this research.

7) Effects of slope on initial runoff-yielding time



The correlation between slope and initail runoff-yielding time

- The relationship between the slope and the initial runoff-yielding time was a negative correlation.
- For a steeper slope, contact angle between rainfall and ground was smaller, less unconsolidated soil was generated by splash erosion, rainfall infiltration was more weakened, and the slope runoff was easier to form, hence the initial runoff-yielding time was shorter.

PART 4

Conclusions

Conclusions

	Precipitation	Rainfall intensity	Slope
TP load	Positive	Positive	Positive
TP precipitation	Positive	Positive	Positive before 15°
Initial runoff-yielding time	Uncorrelated	Negative	Negative

The critical slope of TP loss appeared at degree 15 in this research.

Conclusions

Extension

- The research on critical slope of TP loss from purple soil
- Influential mechanism of underlying surface on nonpoint source pollutants under multiple continuous precipitation scenarios

THANKS!