

Effects of plants materials on the dissipation of herbicide pendimethalin in soil and its microbial communities

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Introduction

Green manure is primarily used in environmentally friendly agricultural practices to reduce the application of chemical fertilizer for many years. However, the effect of green manure on dissipation of herbicide and soil bacteria community was rarely discussed.

Objective

In this study, we tried to discuss the effect of lupin (*Lupinus luteus*) on the dissipation of herbicide pendimethalin in Sankengtzu (Sk) (pH 5.2) and Erhlin (Eh) (pH 7.7) series soil. And the soil bacterial community was also studied by polymerase chain reaction-denaturing gradient gel electrophoresis (PCR-DGGE) during the herbicide dissipation period.

Materials and methods

1. Materials

Pendimethalin used in the experiments were purchased from SUPELCO Co., U.S.A. Soils used in the experiments were Sankengtzu and Erhlin Series. The series were abbreviated as Sk and Eh. The soil physical and chemical properties are listed in table 1. Lupin (*Lupinus luteus*) was collected from TAOYUAN Tea Research and Extension Station. Lupin was air-dried at 70°C and was grinded.

2. Incubation test

Applied the pendimethalin and lupin into soils, and then contained the concentration of pendimethalin in soil at 25.5 mg kg⁻¹ and of lupin in soil at 16 g kg⁻¹. The incubation test was divided into four groups, L group means the soil was only applied with lupin, P group means the soil was only applied with pendimethalin, L+P means the soil was applied with lupin and pendimethalin, and B means the soil was applied with nothing. The experiment was carried out at 28°C. Soil samples were collected at no. 0, 1, 3, 7, 10, 15, 20, 25, 30, 40, 50, 60 to 110 days in order to measure residual pesticides and the sample at 0, 30, 40, 60, 90, 110 days were collected to study soil bacteria community. Residues of pendimethalin in soil were extracted with acetonitrile and analyzed by HPLC. The soil bacterial community was studied by PCR-DGGE.

Results and discussion

Table 1. The physical and chemical properties of soils.

Properties	Sankengtzu, Sk	Erhlin, Eh
Field capacity (%)	0.23	0.27
pH (H ₂ O)	5.2	7.7
EC (dS m ⁻¹)	0.267	2.71
Sand (g kg ⁻¹)	553	227
Silt (g kg ⁻¹)	292	621
Clay (g kg ⁻¹)	292	621
Texture	SL*	SiL*
CEC (cmol(+) kg ⁻¹)	3.06	6.37
TOC (g kg ⁻¹)	6.68	13.72

Sk and Eh soil are different in many in many condition, especially in pH. Soil pH effect the growth of soil bacteria, and further impact the degradation of pesticide in soils.

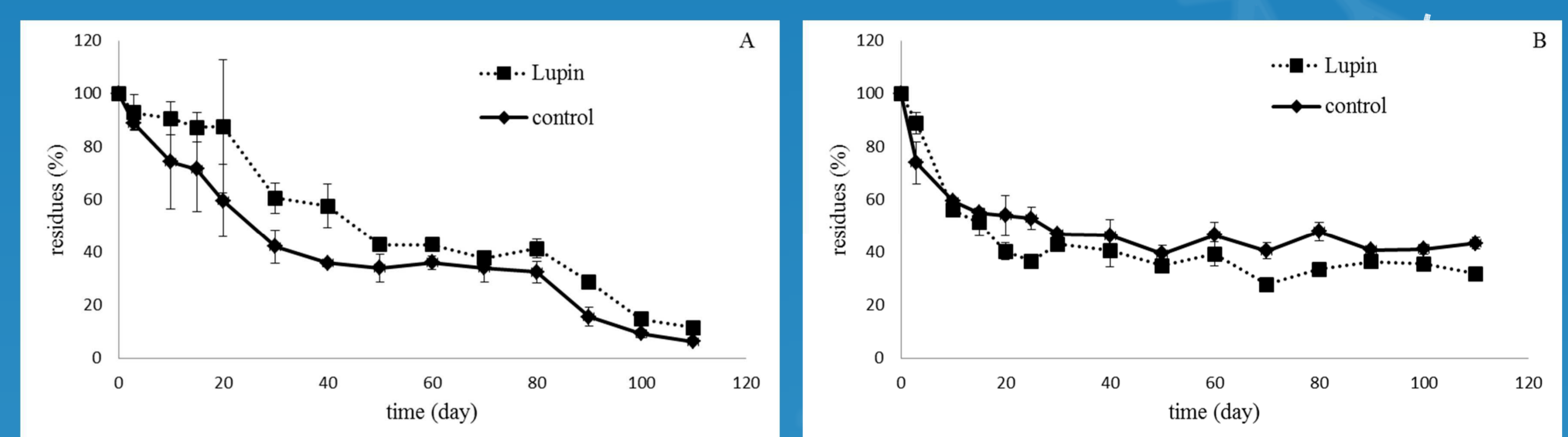


Figure 1. The effect of different amendments on dissipation of pendimethalin in soils. (A) Eh soil (B) Sk soil.

Table 2. The degradation rate constants (K) and half-life (t_{1/2}) of the first order kinetics for pendimethalin.

Treatment	K (day ⁻¹)		R ²		t _{1/2} (day)	
	Sk	Eh	Sk	Eh	Sk	Eh
Control	0.011	0.020	0.81	0.96	62.2	34.8
Lupin	0.014	0.017	0.85	0.96	49.0	46.3

The residue amount of pendimethalin was 6.20% in control and became 11.55% with lupin treatment in Eh soil. Applying lupin did not increase the dissipation of pendimethalin in Eh soil. However, the dissipation rate was faster in lupin treatment and the residue was fewer with lupin (31.79%) treatment than in control (43.34%). The half-life (t_{1/2}) and dissipation rate constant (K) also confirm the above results (Table 2).

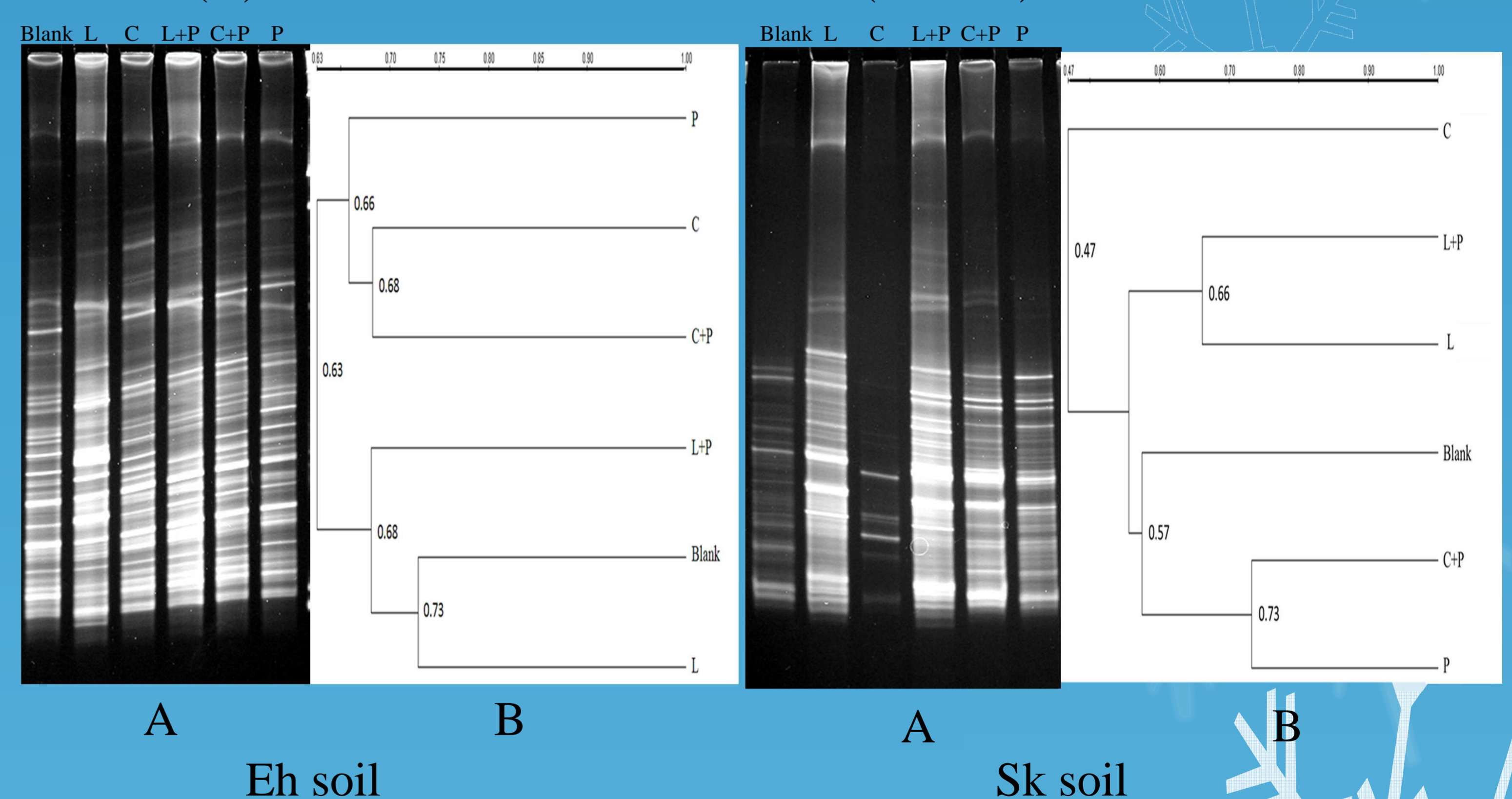


Figure 2. PCR-DGGE analysis of 16S rDNA sequence fragments (A) and cluster analysis of bacterial community structures by UPGMA (B). L: amended lupin; P: amended pendimethalin; L+P: amended lupin and pendimethalin. C and C+P are not discussed in this research.

The microbial community of lupin treatment was not so influenced by pendimethalin in Erhlin soil. In Sk soil, applying lupin could not prevent soil microbial community against pendimethalin

Conclusions

Applying lupin increase the dissipation of pendimethalin in Sk soil, but in Eh soil. Soil pH is the main reason for this difference. Applying lupin and pendimethalin changed the bacteria community of soil. Green manure - lupin would protect soil microbial communities from pendimethalin in Eh soil.