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Different Pesticide Contamination on Biological Properties of Purple Paddy Soil

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The effect of pesticides on anaerobic microbial in purple paddy soil is usually used as an important guide line for estimating the ecological safety of soil. Effects of pesticide contamination on population and activity of bacteria were investigated in purple paddy soil by indoor culture method. The results showed that the population and activity of anaerobic fermentation bacteria and anaerobic nitrogen-fixing bacteria were stimulated slightly by adding carboforan or butachlor in paddy soil, but significantly inhibited by adding of butachlor (10 mg kg^{-1}), carboforan (10 mg kg^{-1}) and carbendazim (0.5 mg kg^{-1}). At the firstly week the inhibition reached the maximum and then gradually reduced down to the level in control. The same effect was found to the activities of urease and neutro-phosphatase by pesticides. The inhibition effects of the pesticide contaminants were gradually attenuating after forth weeks. Pesticide is an important factor affecting the soil microbial population and enzyme activity.

Key words: Purple paddy soil, Pesticide, Biological properties.

Pesticide plays a very important role in the prevention and cure of illness, insects and grass, ensuring a stable high yield in agriculture. But the dose of pesticide is too heavy and exceeds the decomposition ability of surroundings, pesticide and its deleterious decomposition may accumulate in the some areas soil in China (Sneh Goyal *et al.,* 1999).

The dose of pesticide is becoming heavier and the environment contamination is getting graver.

Thereby, the bio-balance in the paddy field has been changed, and the bio-change of pesticide in the paddy soil has also been influenced. The soil contamination with pesticide has aroused attention from the academics and the public. Various microorganisms in natural environment play an important role in pesticide degradation. As long as the dose of pesticide exceeds the decomposition ability of soil, pesticide may accumulate in soil and it certainly would affect the characteristics and functions of microorganisms in the soil. Anaerobic fermentation bacteria and anaerobic nitrogen-fixing bacteria played an important role in organic carbon decomposition, nitrogen cycling and greenhouse gases generating (Xinbin *et al*., 2012). This paper, selecting bactericide (Carbendazim), weed-killer (Butachlor), insecticide (Furan) as representatives of pesticide, the feasible impact of different pesticides on biological properties of purple paddy soil was explored. In order to provide scientific basis for the safe and rational use of pesticides, pollution prevention and evaluation of pesticide's effect on soil ecological security.

MATERIALS AND METHODS

Tested Soil

Soil samples were collected from purple paddy soil cultivation layer (0 ~ 20 cm) in "National Purple Soil Fertility and Fertilizer Effective Long-

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term Location Experiment" farm, Southwest University. Physical and chemical properties of the tested soils were as follows: content of soil organic matter 32.1 g kg^{-1}, Total N 1.52 g kg^{-1}, available N, available P and available K were relatively 83.1 mg kg^{-1}, 4.3 mg kg^{-1} and 88.2 mg kg^{-1}, and pH of 7.27.

Visible gravels were removed from sample soil and organic residues remained. Certain copies of soil (equivalent to 1000 g dry soil) were placed in 1300 ml clean plastic box, and water was added to keep the soil waterlogged, and it was pre-cultured in 28 °C (constant temperature) for 3 weeks, in the purpose of microbial rejuvenation, especially for anaerobic microbial. It was pre-cultured for 3 weeks for post-pesticide treatment.

EXPERIMENTAL

Several boxes of soil which was pre-cultured for 2 weeks were added different concentrations (mg kg^{-1}) of carbofuran (0, 1, 10, 50), carbendazim (0, 0.5, 5, 50) and butachlor (0, 1, 10, 50), the process was repeated 20 times, and soil samples were mixed sufficiently at 28 !. After 0, 7, 14, 21, 28 days of culture, the samples (3 boxes) were tested for the population of microbial communities and their activity. Throughout the culture period, water was added momentarily, so the water level remained above the soil 1 ~ 2 cm, simulating the anaerobic environment of paddy field.

Determination of paddy soil microbial activity

Measurement and counting of paddy soil anaerobic fermentation bacteria was referred to in literature (Zeshu *et al*., 1985).

Measurement and counting of paddy soil anaerobic nitrogen-fixing bacteria was referred to in literature (Hang *et al*., 1993).

Measurement of Urease activity was referred to in literature(Guanghui *et al*., 1986).

Measurement of neutro-phosphatase activity was referred to in literature (Hang *et al*., 2001).

Data Analysis

All test data were the averages of three repeated tests, and data analysis were processed by SPSS 18.0 for windows software.

RESULTS

Impact of pesticide contamination on the quantity of soil anaerobic fermentation bacteria quantity

The inhibition rate is the comparison of pesticide using and no pesticide with the increase and reduction of bacteria quantity. Figure 1 and table 1 displays the impact of pesticide over the quantity of soil anaerobic fermentation bacteria and the inhibition rate of different densities of different pesticides to soil anaerobic fermentation bacteria. The impact of Furan, Carbendazim, and Dutachlor over the quantity of bacteria in purple paddy soil were similar. Both that without pesticides and low-density of 3 pesticides to anaerobic fermentation bacteria reached the crest value in the second week, while the medium-density and high-density of 3 pesticides had impetus to soil anaerobic fermentation bacteria as time went by. Within the 4-week experiment, as time went, the

Table 1. The inhibition rate of different pesticides to soil anaerobic fermentation bacteria

The different pesticides	Dose (mg kg^{-1})	The inhibition rate of different time(%)			
		7d	14d	21d	28d
Furan	1	10.1	14.9	23.7	11.6
	10	-48.0	-67.0	-30.6	4.9
	50	-79.9	-84.9	-63.3	-57.5
Carbendazim	0.5	-14.2	-2.9	4.8	5.6
	5	-60.3	-67.0	-21.5	-3.4
	50	-84.0	-83.8	-67.5	-59.0
Dutachlor	1	13.5	27.3	28.6	15.3
	10	-38.6	-45.6	-22.6	-4.5
	50	-71.9	-83.2	-51.8	-30.1

Table 2. The inhibition rate of different pesticides to soil anaerobic nitrogen-fixing bacteria

The different pesticides	Dose (mg kg^{-1})	The inhibition rate of different time(%)			
		7d	14d	21d	28d
Furan	1	9.1	5.2	8.4	11.6
	10	-14.9	-10.0	6.6	13.4
	50	-38.4	-25.7	-9.6	-0.5
Carbendazim	0.5	-8.9	-3.1	5.2	3.2
	5	-24.9	-21.2	-1.2	5.8
	50	-47.5	-45.9	-19.9	4.8
Dutachlor	1	14.6	7.6	6.9	2.9
	10	-19.2	-20.4	7.1	9.8
	50	-36.2	-29.2	-10.6	4.5

quantities of anaerobic fermentation bacteria increased. The anaerobic fermentation bacteria by 3 low-density pesticides reached the crest value in the four weeks. As a whole, within the four weeks, the anaerobic fermentation bacteria in purple paddy soil increased by 68.09% without pesticides; the anaerobic fermentation bacteria by different density of 3 pesticides increased 46.38%, 62.99% and 44.22% respectively. The increasing rate was more obvious by adding Carbendazim. The anaerobic fermentation bacteria by 3 low-density pesticides reached the crest value in the four weeks.

Anaerobic fermentation bacteria were sensitive to the 3 pesticides. Furan and Carbendazim had obvious impetus to anaerobic fermentation bacteria in low-density (1 mg kg^{-1} and 0.5 mg kg^{-1}). Nevertheless, when the density of Furan and Carbendazim reached 10mg kg^{-1} and 5mg kg^{-1}, the inhibition became more obvious. Compared to that without any pesticides, the inhibition rate would get 48% and 60%, reaching the alerting point of living safety.

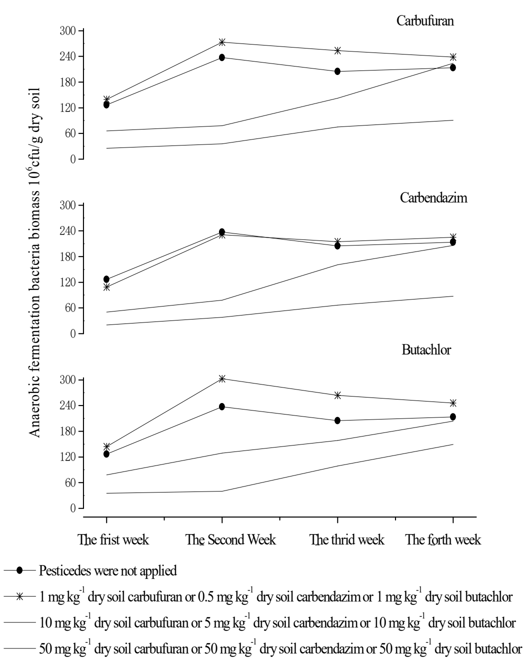

Fig. 1. Effect of pesticide pollution on the activities of anaerobic fermentation bacteria

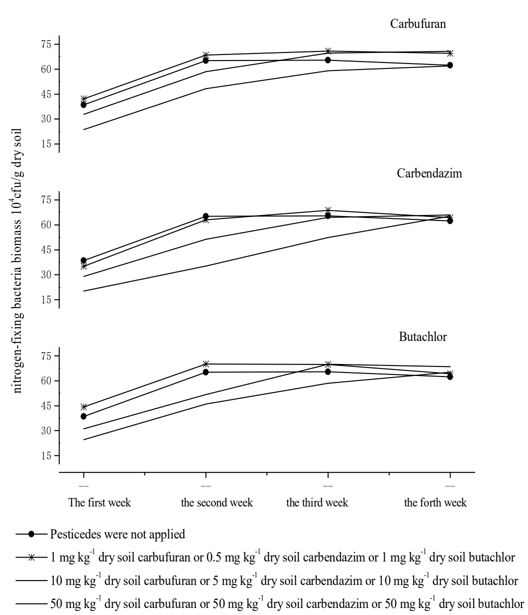

Fig. 2. Effect of pesticide pollution on the activities of soil anaerobic nitrogen-fixing bacteria

Fig. 2 and table 2 displays the impact of pesticide over the quantity of soil anaerobic nitrogen-fixing bacteria and the inhibition rate of different densities of different pesticides to soil nitrogen-fixing bacteria. Compared with anaerobic fermentation bacteria, nitrogen-fixing bacteria were less inhibited by the 3 pesticides. Low-density of Furan and Dutachlor had impetus to nitrogen-fixing bacteria in purple paddy soil, while the high-density had inhibitions. The inhibition would become weaker as time went and there was no inhibition after 28 days. Nitrogen-fixing bacteria were stimulated in almost all the densities of Carbendazim, which indicated that nitrogen-fixing bacteria were adaptable to pesticides.

Impact of pesticide contamination over Urease activity in purple paddy soil

The impact of Dutachlor over urease was less than that of the other two pesticides. Urease activity would be stimulated if 1mg Dutachlor was added into 1mg paddy soil. 7 days later, urease activity was 9% higher than that without any pesticides, and it was always higher than that without any pesticides in the 28 days. When the doses of Dutachlor were 5mg kg^{-1} and 50 mg kg^{-1}, urease activity was seriously inhibited and the inhibition rates were 13% and 31% respectively. The higher the doses were, the stronger the inhibition was. Anyhow, the inhibition would gradually reduce day after day. At the 21 day, urease activity was the same as that without pesticides.

Impact of pesticide contamination over neutro-phosphatase activity

Neutro-phosphatase was the most sensitive enzyme to high-density pesticides among the four enzymes, and the inhibitions to phosphatase by high-density pesticides were higher than the other three enzymes. Anyhow, the impact of pesticides over phosphatase was similar to that over other enzymes. If 0.5mg Carbendazim was added in 1kg paddy soil, phosphatase activity would be inhibited. 7 days later, the phosphatase activity dealt with by Carbendazim was 11% lower than that without any pesticides (Fig. 4). As time went by, Carbendazim was gradually decomposed and its inhibition was reduced. At the 21 day, phosphatase activity was the same as that without pesticides. When the doses of Carbendazim were 5mg kg^{-1}and50 mg kg^{-1}, phosphatase activity was seriously inhibited. The inhibition rates were 28% and 56% respectively. The impacts of Furan and Dutachlor over phosphatase activity were somewhat similar. Low density would stimulate

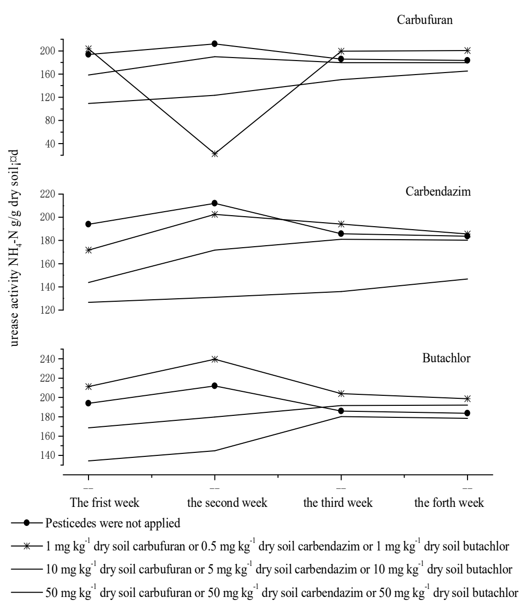

Fig. 3. Effect of pesticide pollution on the activites of soil urease activity

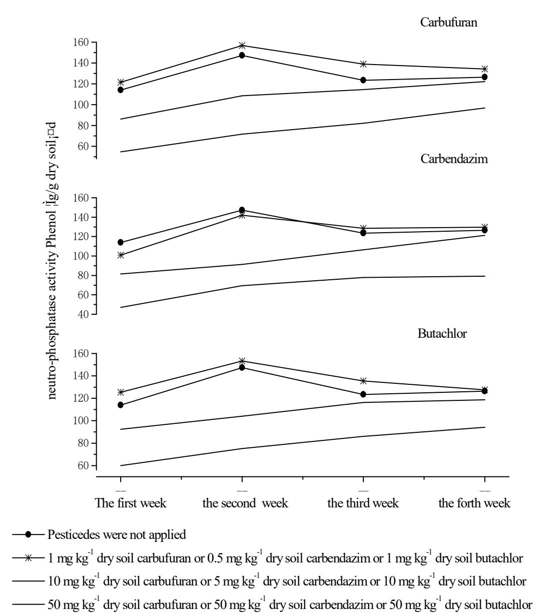

Fig. 4. Effect of pesticide pollution on the activites of soil neutron-phosphatase

phosphatase activity, and high density inhibited phosphatase activity.

CONLUSION

Pesticide is an important factor affecting the soil microbial population and enzyme activity. The population and activity of anaerobic fermentation bacteria and anaerobic nitrogen-fixing bacteria were stimulated slightly by adding carboforan or butachlor in paddy soil, but significantly inhibited by adding of butachlor (10 mg kg^{-1}), carboforan (10 mg kg^{-1}) and carbendazim (0.5 mg kg^{-1}). The inhibition effects of the pesticide contaminants were gradually attenuating after forth weeks. By appropriate choice of Microbiology and soil enzyme indicators can be used as pesticide pollution assessment indicators.

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REFERENCES

1. Sneh Goyal K., ChanderM, M., Influence of inorganic fertilizers and organic amendments on soil organic matter and soil microbial properties under tropical conditions. *Biol. Fertil. Soils*, 1999; **29**: 196-200.
2. Xinbin Z., Xiaojun S., Lamei Z., Yongxiang Z. Effects of pesticide-contamination on population and activity of bacteria in purple paddy soil. *Energy procedia*. 2012; **16**: 284-289.
3. Zeshu Q., Hang M. (ed): Sludge gas fermentation microbiology. Hangzhou: Zhejiang Science and Technology Press, 1985; pp 23-100 (In Chinese).
4. Hang M. (ed): Anaerobic Microbiology. Hangzhou: Zhejiang University Press, 1993; pp 8-23. (In Chinese).
5. Guanghui X., Hongyuan Z. Handbook of soil microbiology analysis method. Beijing: Agricultural Publishing House, 1986; 29-67. (In Chinese).
7. Hang M., Yangfang Y. Effects of butachlor on microbial populations and enzyme activities in paddy soil. *J. Environ Sci. Health*, 2001; **B36**(5): 58l-595.