

Retention Capacity for Isoxathion in Soils Applied With Woodchip Biochar



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Introduction

Use of pesticides in agriculture has become an inevitable practice to maintain or improve the soil productivity. However, their long-term and overdose applications can cause deteriorate the quality of soil biota, accumulate in soil and crops, and threaten users' health. Moreover, intense and/or prolonged rainfall can cause leaching and dissipation of pesticides from soil, then lose its effects, which may require continuous application of pesticides in some cases.

Due to its high adsorption capacity, biochar application to soil may reduce the dissipation of applied pesticides and increase residence time in soil. With prolonged residence time hence its effects in soil, the amount and frequency of pesticides applied to soil can be reduced, therefore problems associated with pesticide application can be alleviated.

The objective of this study was, therefore, to investigate the effect of biochar application to soil on adsorption and residence of pesticide in the soil.

Materials and Methods

1. Soil, biochar, and pesticide

A Japanese agricultural soil (subsurface Andisol in Tokyo) was air-dried and sieved through a 2 mm sieve. A woodchip biochar (made from wood waste at Toyohashi, Aichi) was pyrolysed at 700°C, crashed, and sieved through a 300 µm sieve. A pesticide used was isoxathion, one of the most used organophosphate pesticides in Japan, applied at 8 mg kg⁻¹.

2. Incubation experiment

For the incubation experiment, 50 g of soil was weighed into 125 mL plastic bottle, mixed with the biochar at application rates of 0%, 1%, 5%, and 10% (w/w). After mixed well, isoxathion and water were applied and mixed well. Soil water content in the bottle was kept at 50% throughout the experiment. The triplicate bottles were placed in dark. After 7, 14, 21, 28, 42 and 56 days of incubation, isoxathion concentration, pH and EC were analyzed in the mixture. Control with soil only with no biochar nor isoxathion was included.

Characteristics of Soil and Biochar

The pH of soil and biochar were measured with 2.5:1 with water. Total-C and Total-N were analyzed by CHN elemental analyzer. Total-P and available-P were analyzed by spectrophotometer with molybdenum blue method.

Table 1 Selected properties of the soil and biochar.

	Bulk density	pH	EC	Total-C	Total-N	Total-P	Available P	C/N
	(g cm ⁻³)		(dS m ⁻¹)	(g kg ⁻¹)	(g kg ⁻¹)	(g kg ⁻¹)	(mg kg ⁻¹)	
Soil	0.67	7.17	0.046	6.0	0.52	0.326	20.0	11.5
Biochar (700°C)	0.55	10.24	0.881	763.7	4.26	0.154	34.0	179.3

The Andisol contained total-C of 6.0 g kg⁻¹ and total-P of 0.326 g kg⁻¹ (Table 1). The total-P of the biochar (0.154 g kg⁻¹) was about a half of that of the Andisol. Available-P was 20.0 and 34.0 mg kg⁻¹ in the Andisol and biochar, respectively.

Change over time of the EC and soil pH and isoxathion concentration

Isoxathion concentration decreased significantly after 14 days of incubation in the all treatments (Fig. 1). The isoxathion was not detected in the control with no pesticide added, therefore the soil itself was not contaminated with isoxathion. The soils with 0%, 1%, 5%, and 10% biochar application rates contained 5.18, 7.58, 5.60 and 11.56 mg isoxathion kg⁻¹ soil at 7 days, respectively, then decreased to 0.29, 3.23, 4.05 and 1.80 mg kg⁻¹ at 56 days, respectively. Isoxathion is readily degradable by soil microbes, as seen in soil without biochar application (0% rate). The isoxathion concentration in all biochar-amended soils remained higher than that of unamended soil. It is inferred that isoxathion was adsorbed in micropores of biochar, hence protected against soil microbial decomposition.

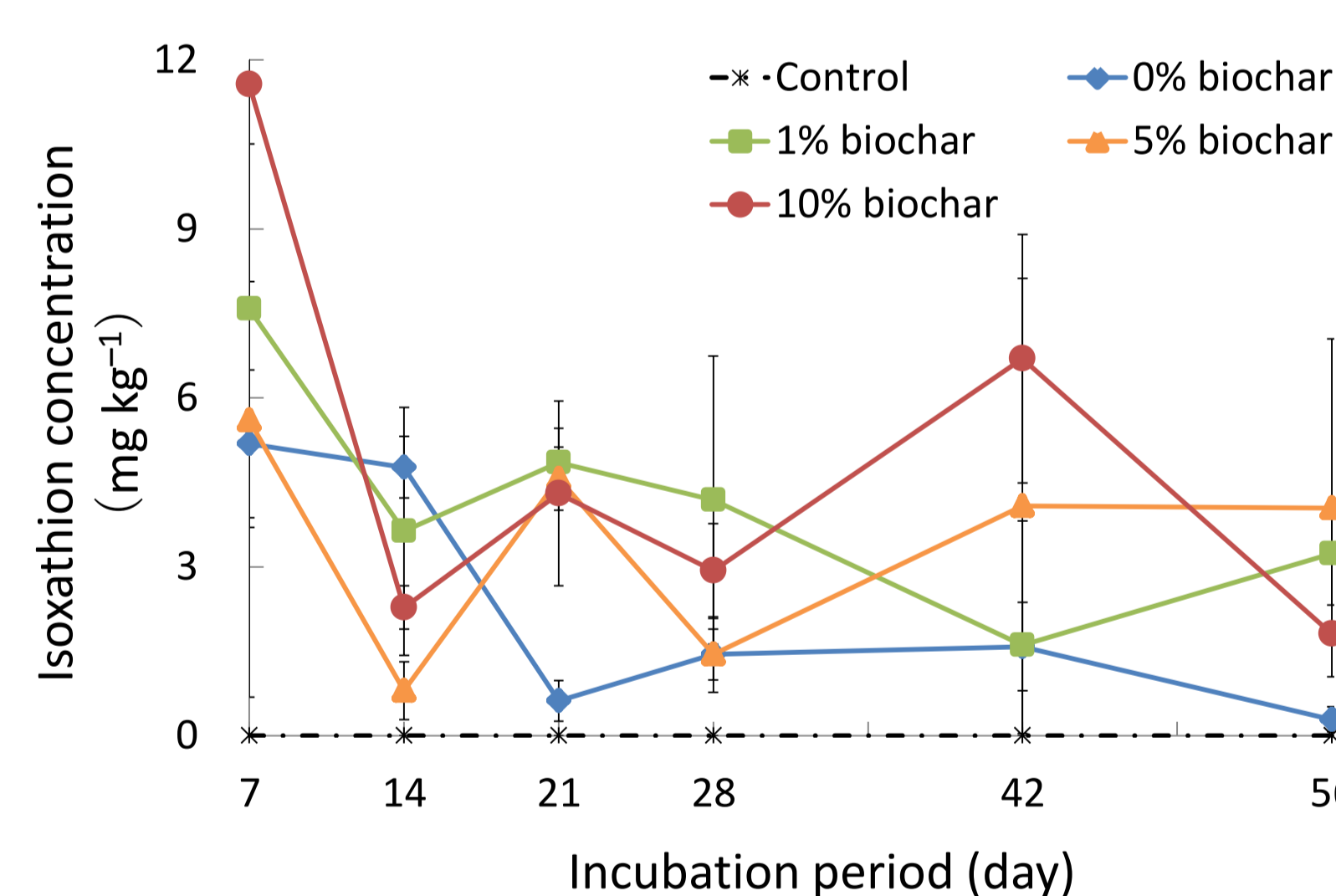


Fig. 1 Change of the isoxathion concentration overtime

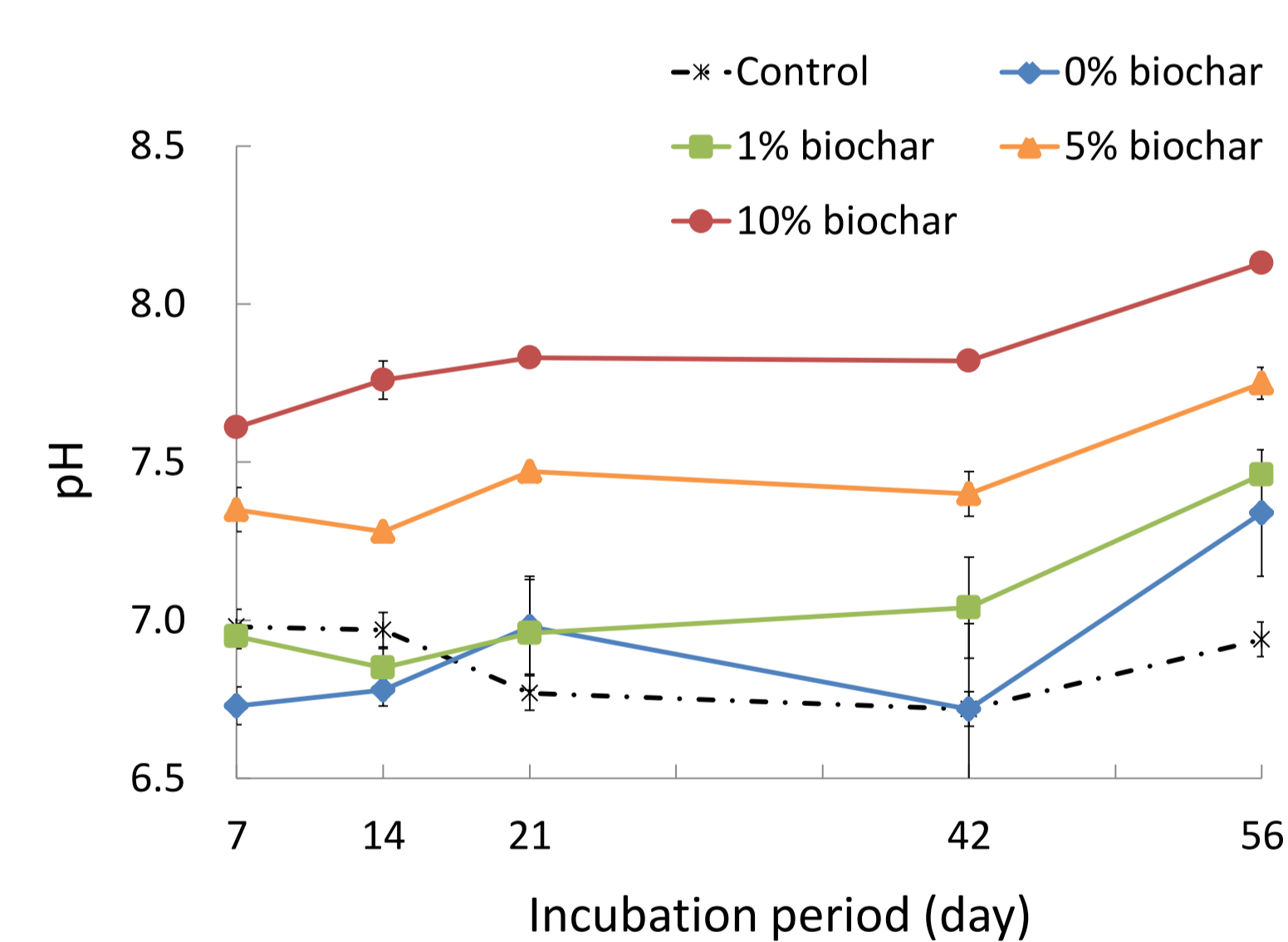


Fig. 2 Change of the pH overtime

Soil pH of the unamended soils slightly fluctuated but remained relatively constant throughout the incubation (between 6.72 and 6.98 for both control and 0% rate, except for 7.34 at 56 days with 0% rate; Fig. 2). On the other hand, soil pH with 1%, 5%, and 10% rates increased with the increasing application rate and gradually increased over time (between 7.46 and 8.13) due to high pH of the biochar (10.24). Increasing soil pH up to >8 might have negatively affected soil microbial activity, which hence could have contributed to isoxathion survival in the soil especially with 10% rate.

Except for control, soil EC in the biochar-amended soils increased with the increasing application rate at each incubation day, however gradually but only slightly decreased over time within each treatment. EC increases with the application rate was most likely due to nutrients supplied from biochar.

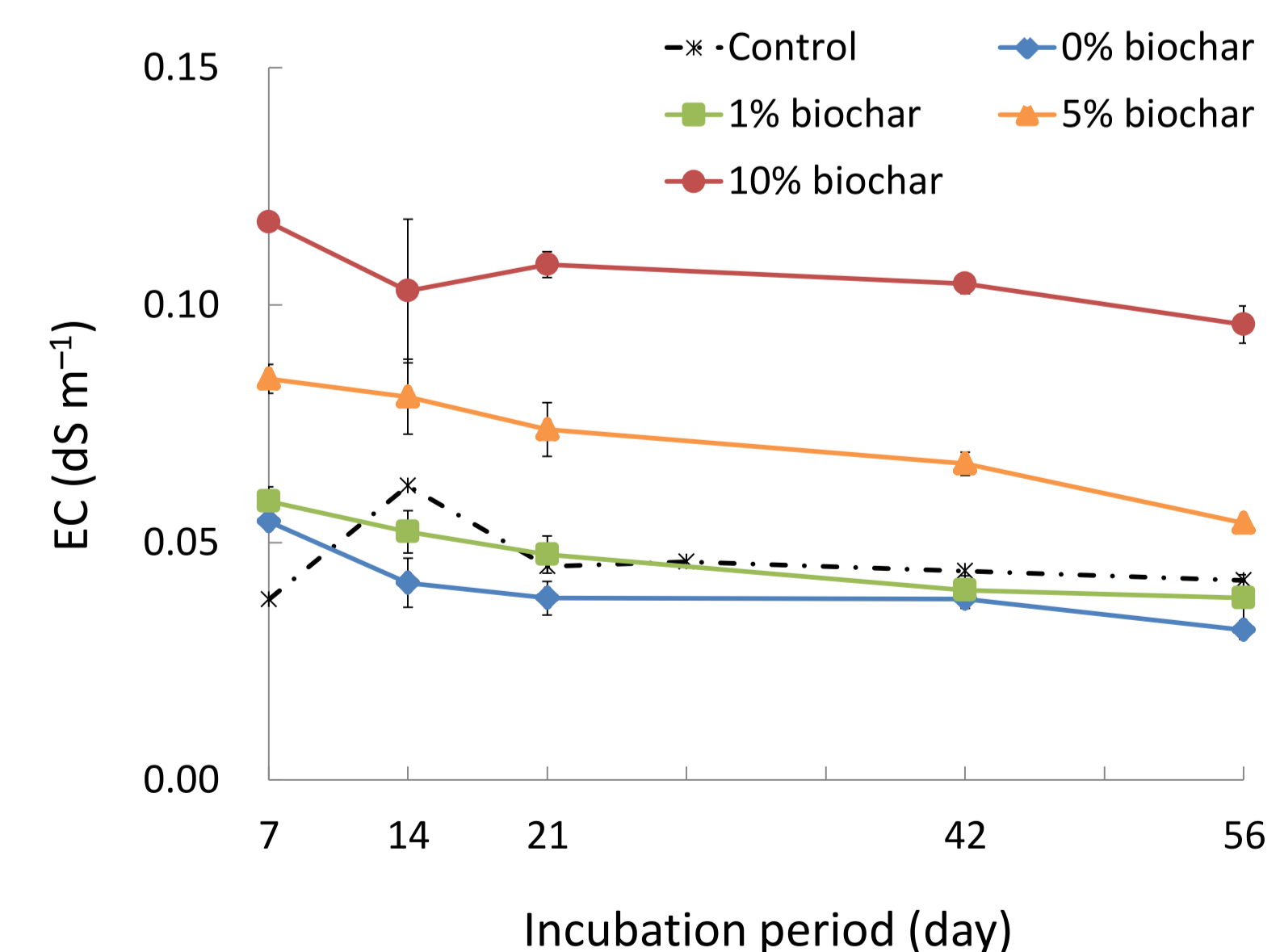


Fig. 3 Change of the EC overtime

Conclusion

- It appeared that isoxathion was adsorbed in the micropores of biochar, hence its residence time was prolonged.
- Further studies are needed to investigate relationships between biochar application and pesticide dynamics in soils.

Reference

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