J. Korean Agric. Chem. Soc.
한국농화학회지 31(2), 200—204 (1988)

Effect of Some Soil Properties on Degradation of Herbicide Pretilachlor in Soils

Young-Hee Moon, Sang-Yong Ma, Ik-Sun Jang and Hwan-Seong Ryang

Department of Agricultural Chemistry, Chonbuk National University,
Chonju, Chonbuk, Korea

土壤中에 있어서 除草劑 Pretilachlor의 分解性에 미치는 몇가지 土壤特性의 影響

文永熙 · 馬祥壎 · 張益銑 · 梁桓承

全北大學校 農化學科

초 록

土壤中에 있어서 除草劑 pretilachlor의 分解性에 미치는 土性, 有機物含量, 溫度, 水分狀態의 影響에 대하여 硏究하였다. 土壤中 pretilachlor의 殘効期間은 60g a.i./10a 處理水準에서 約 50日였으며, 피에 대하여 GR 50値까지 달하는 期間은 約 25~27日이었다. pretilachlor의 分解速度는 砂壤土에서 보다 有機物과 粘土의 含量이 높았든 砂質埴壤土에서 빨랐다. 土壤中 pretilachlor의 分解는 有機物添加에 의하여 促進되였으며, 20°C에서 보다 30°C에서, 濕潤條件下에서 보다 湛水條件下에서 빨랐다.

Introduction

The soil-applied herbicide pretilachlor (2-chloro-2', 6'-diethyl-*N*-(*n*-propoxyethyl) acetanilide) is recently used to control most annual weeds in rice paddy fields. For effective and safe application, the study on behaviour of the herbicide in soils and plants is very important. However, researches on the pretilachlor are few. Therefore, in our previous study,[1] the movement of pretilachlor in the soils and the plants was examined. In this study, the effect of soil texture, soil temperature, soil moisture and content of organic matter on the degradation of pretilachlor in soil was examined.

Received February 22, 1988
Corresponding Author: H.S. Ryang

Meterials and Methods

Herbicide and Soil

The used herbicide pretilachlor was supplied by CIBA-GEIGY Co., LTD. and the purity was more than 99%. Also, pretilachlor of a.i. 10% wettable powder was used.

The used soil was collected form the surface 10cm paddy field at Chonju and Okgu, Chonbuk. The soil was passed through a 2mm mesh sieve and stored at 7°C and room temperature in large polyethylene bags until used. The main properties of the soils are shown in Table 1.

Residual activity of the herbicide in the soil

Air-dried soils (sandy clay loam, sandy loam soil) were separately placed in six plastic vats (area 1,200cm², height 20cm) and flooded with water up to 2cm depth. The three vats were

Table 1. Some properties of soil samples used

Sampling place	Soil texture	Particle size distribution(%)			pH	Organic matter (%)	C.E.C. (me/100g)
		Sand	Silt	Clay			
Chonju I	S C L	50.2	21.8	28.0	5.2	2.5	13.4
Chonju II	C L	41.6	30.6	27.7	5.7	1.9	11.6
Okgu	S L	64.6	20.6	14.8	7.0	0.7	8.8

treated with the 10% wettable powder pretilachlor at rate of 60g a.i./10a and the other three vats without any treatments were used as the control. As test plant, twenty germinated seeds of barnyard grass (*Echinochloa crus-galli*) were sown in the designed site of vats at intervals of 5 days, and grown them in the glasshouse at 25°~30°C for 10 days. The plant height was measured. The period of residual activity of pretilachlor in the soils was determined by the rate of inhibition contrast to the control.

Decomposition of the herbicide in the soil

For routine experiments, 10g soil on dry basis was placed in a test tube (length 18cm, i.d. 3cm). The tube was flooded with 20ml of water and the mouth of tube was covered with aluminimum foil. The tube was preincubated at 30°C for 10 days.

Following the preincubation, pretilachlor dissolved in acetone was added to the soil at rate of 5μg/g on dry basis, and mixed it thoroughly with the soil by stirring. These soils were incubated at 30°C for 1, 2, 3, 5 and 8 weeks. These tubes were removed for analysis after the incubation.

To determine the effect of soil texture on the degradation, sandy clay loam (Chonju I) and sandy loam(Okgu) soil were used. To study the effect of organic matter, clay loam soil added with 0 and 3% compost which was piled under the natural conditions for 2 years was used. To study the effect of moisture regime, the clay loam soil was adjusted to the flooded conditions and wetted conditions, in which soil moisture was 40%. To determine the effect of soil temperature, the clay loam soil was incubated at 20°C and 30°C.

Extraction and analysis of pretilachlor

The incubated soil was trasnfered into 250ml Erlenmeyer flask and washed with 100ml of acetone. The flask was capped tightly and shaken on vertical shaker for 1 hour. Then the soil was filtered. The sedimented soil was extracted once more with 50ml acetone. The combined acetone solutions were concentrated under reduced pressure below 40°C. The concentrated solution was extracted 3 times, each with 30ml *n*-hexane. The hexane extracts were dehydrated, evaporated, and diluted with 2ml *n*-hexane again. For the determining pretilachlor, the solution was subjected to Pye Unicam Series 304 gas chromatograph equipped with electron capture detector. A glass column (1.5m×2mm i.d.) packed with 8% OV-17 on Chromosorb W (80~100mesh) was used. The operating temperatures of detector, column and injection part were 290°C, 265°C and 275°C, respectively. Flow rates of N_2 gas as carrier and purge gas were 70 and 30ml/min., respectively.

Results and Dicussion

Residual activity

The residual activity of pretilachlor in the two soils was determined by barnyard grass which was very sensitive to pretilachlor.[1] The growth of barnyard grass in the soils treated with pretilachlor at rate of 60g a.i./10a was completely inhibited before 15 days after the treatment but decreasing inhibition gradually after that at

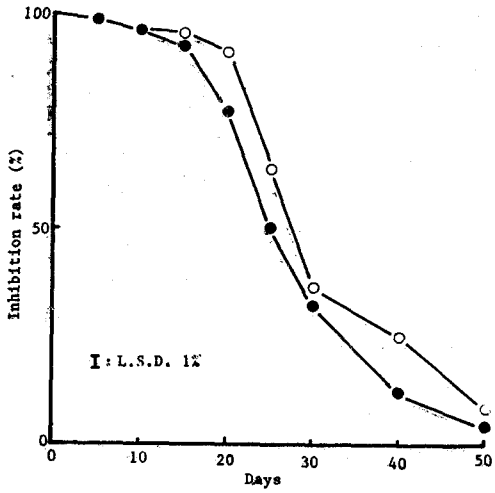

Fig. 1. Residual activity of pretilachlorby inhibition rate of barnyard grass in the two soils under flooded conditions

shown in Fig. 1. On the other hand, the inhibition rate of growth at the 50 days after treatment was below 10% compared with the control. Therefore, the period of residual activity of pretilachlor in the soils may be about 50 days. In the comparison with two soil, the growth rates in two soils after 20 days of the treatment were significantly different. To reach GR 50 value (concentration of 50% growth retardation on test plant, barnyard grass), it took about 25 and 27 days in sandy clay loam and sandy loam, respectively. The inhibition rate decreased more rapidly in sandy clay loam than in sandy loam. This may be indicated that the pretilachlor was degraded more rapidly in sandy clay loam than in sandy loam as shown in Fig. 2. It was presumed that the fast inactivation in the sandy clay loam may be due to high content of organic matter and clay in contrast to the sandy loam soil (Table 1). Because it was reported that contents of organic matter and clay affected to degradation of herbicides in soils.[2] The period of reaching GR 50 value of pretilachlor in this experiment was short compared with the other reports, which the period of pyrazolate[3] and pyrazoxyfen[4] was 40~50 days under the conditions like this study.

The effect of some soil conditions on the degradation

The degradation rate of herbicide is generally affected by the factors such as some soil properties and other environmental conditions.[2] In this study, the effect of some factors on degradation rate of pretilachlor in the soils was examined. Degradation rates of pretilachlor in the two soils were followed logarithmic regression lines as shown in Fig. 2. The degradation was rapider in the sandy clay loam than in the sandy loam. The halflives obtained from the regression slopes in sandy clay loam and sandy loam were 5 and 9 days, respectively. This is similarto the result of residual activity (Fig. 1). Lode[5] indicated that organic matter was a important factor in degradation of herbicide and Zimdahl et al.[6] reported that alachlor, metolachlor and propachlor which were acetamide herbicide as pretilachlor were rapidly degraded in the clay loam in which contents of organic matter and clay were higher than sandy loam. The rapider degradation of pretilachlor in sandy clay loam soil, therefore, may be due to high

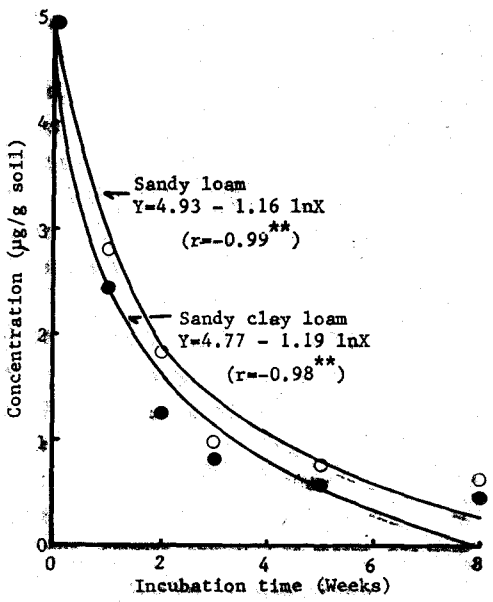

Fig. 2. Degradation of pretilachlor in the two soils under flooded conditions

contents of organic matter and clay in the soil more than the sandy loam soil. On the other hand, though loss of herbicide is generally affected by leaching in the soils with low content of organic matter and clay, the influence is not considerable in this experiment, because the experiment is carried out under the nonleaching conditions in the laboratory.

The more detail study on the effect of organic matter addition, temperature regime and water regime in the degradation of pretilachlor was performed and the result was shown in Fig. 3. The degradation curves under the addition of organic matter(flooded, 30°C) and the control (flooded, 30°C) were followed logarithmic regression lines. The curves under the 20°C (flooded) and the wetted condition were followed exponential regression lines. In the effect of addition of organic matter on degradation of pretilachlor in soil, the half lives obtained from the regression slopes under the conditions of addition and non-addition(control) were 7 and 8 days, respectively. The degradation rate in the soil was accelerated by addition of organic matter. This perphaps supports that the degradation rate of pretilachlor is increased in soil containing organic matte rlargely (Figs. 1 and 2).

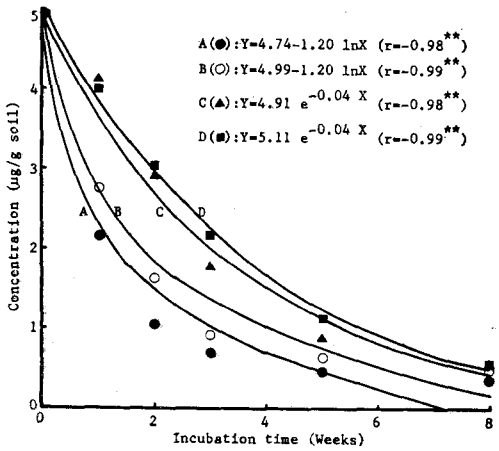

Fig. 3. Degradation of pretilachlor in the soil under some different conditions

A(●) : addition of organic matter(flooded, 30°C)
B(○) : control (flooded, 30°C)
C(▲) : wetted condition (20°C)
D(■) : 20°C(flooded)

On the other hand, Obrigawitch[7] and Walker[8] reported that the degradation of herbicides in the soils is greatly affected by soil temperature, though the degree of effect on the kinds of herbicides was different. And also Zimdahl[6] indicated that the degradation of some acetamide herbicides in soil was influenced by soil temperature. In this experiment, it was revealed that the degradation of pretilachlor in the soil was also affected by soil temperature and the rate of degradation was rapider under the 30°C soil temperature than under the 20°C and the half life obtained from the regression slopes under the 30°C was shorter 9 days compared with the 20°C. The promotive effects of soil temperature and soil organic matter regime may be due to a consequent increase in the population of pretilachlor degrading microbes as other herbicide degradations.[9,10]

In the effect of soil moisture on the degradation of pretilachlor in the soil, the half lives obtained from the regression slopes were 8 and 16 days under the flooded condition and wetted condition (water content of soil : 40%), respectively. As many studies indicated that degradation of pesticides in soils was remarkably affected by soil moisture regime,[11~14] it is indicated that degradation of pretilachlor in soil is affected by conditions of soil water and that the degradation may occurred more rapidly under the flooded conditions (anaerobic conditions) than under the wetted conditions (aerobic conditions).

In these results, although the period of reaching GR 50 value was about 25~27 days, degradation rate of pretilachlor in soils was the order of organic matter addition (flooded, 30°C), control (flooded, 30°C), wetted condition (30°C) and 20°C(flooded), Thus, results of the present study indicate conclusively that degradation rate of pretilachlor in soils is greatly affected by edaphic factors such as regimes of organic matter, temperature and moisture.

Abstract

This study was conducted to evaluate effect of soil texture, organic matter, temperature and water regime on degradation of pretilachlor (2-chloro-2', 6'-diethyl-*N*-(*n*-propoxyethyl) acetanilide) in the soils. The period of residual activity in soil treated with pretilachlor at rate of 60g a.i./10a was about 50 days. Also, period of reaching GR 50 value on the barnyard grass was about 25~27 days. Degradation rate of pretilachlor in the sandy clay loam soil which has higher contents of organic matter and clay was faster than in the sandy loam soil. When organic matter was added to the soil, the rate of decomposition was accelerated. The faster degradation occurred under the 30°C soil temperature by comparison under the 20°C. The rate of degradation in the soil was faster under the flooded conditions than under the wetted conditions.

References

1. Ma, S.Y., Moon, Y.H. and Ryang, H.S.: J. Korean Agr. Chem. Soc., 30 : 351(1987)
2. Hiltobold, A.E.: Pesticide in Soil and Water, ed. by Guenzi, W.D., Soil Science Society of America, Inc., Publisher, Madison, Wisconsin, pp. 203(1974)
3. Ryang, H.S., Han, S.S. and Kim, K.H.: Korean J. Weed Sci., 3 : 174(1983)
4. Ryang, H.S. and Ko, S.Y.: Bulletin of the Agri. College Chonbuk Nat. Univ., 15 : 55 (1984)
5. Lode, Q.: Weed Res., 7 : 185(1967)
6. Zimdahl, R.L. and Clark, S.K.: Weed Sci. 30 : 545(1982)
7. Obrigawitch, T., Wilson, R.G., Martin, A.R. and Roeth, F.W.: Weed Sci. 30 : 175(1982)
8. Walker, A.: Weed Res. 18 : 305(1978)
9. Duah-Yentumi, S. and Kuwatsuka, S.: Soil Sci. Plant Nutr., 24 : 541(1981)
10. Dojoubiseibutsu-kenkyukai: Tsuchinobisebutsu. Hagkyusha, Tokyo(1981)
11. Solbakken, E., Hole, H., Lode, O. and Pedersen, T.A.: Weed Res. 22 : 319(1982)
12. Walker, A. and Zimdahl, R.L.: Weed Res., 21 : 255(1981)
13. Zimdahl, R.L., Catizone, P. and Butcher, A.C.: Weed Sci., 32 : 408(1984)
14. Ishikawa, K., Nakamura, Y. and Kuwatsuka, S.: J. Pesticide Sci., 1 : 49(1976)