

除草剤ブタクロールの水田における分解および消失

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Degradation and Dissipation of Herbicide Butachlor in Paddy Fields*

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In laboratory tests, different ranges of pH did not affect the degradation of butachlor [2-chloro-2',6'-diethyl-N-(butoxymethyl)acetanilide] in aqueous solution, but the volatilization from aqueous solution and the adsorption of butachlor on soil were significantly influenced by temperature. Leaching of butachlor in soil columns correlated with leaching rates and the amount of butachlor applied. The growth of rice seedlings was inhibited at a concentration of 0.5 ppm in the nutrient solution. The growth of *Chlorella vulgaris* was inhibited at a concentration of 0.1 ppm.

In field experiments, at 2nd crop in August, the maximum concentration (2.16 ppm) was obtained during the 1st day of application by the conventional method, but decreased rapidly (<0.1 ppm) after 4 days in the water from paddy fields. The surface soil (0-3 cm) contained a maximum amount (9.17 ppm) in the 1st day and decreased (<0.5 ppm) during a 4-day period. Uptake of butachlor by rice plants resulted in 31.2 ppm during the 1st day, and decreased rapidly to a non-detectable level after 4 days. Some differences were observed between the results with 1st crop (March) and 2nd crop, probably due to the different climate of the seasons. When butachlor residues in the water of drainage ditch nearby paddy fields (treated about 3 days to 1 week before sampling) were checked, the amount of butachlor was found to be less than 0.06 ppm and disappeared about in 1 month.

INTRODUCTION

Butachlor [2-chloro-2',6'-diethyl-N-(butoxymethyl)acetanilide, Machete®] is a pre-emergence herbicide which has been officially

recommended in Taiwan for the control of weeds of transplanted rice in paddy fields since 1971. In the previous paper, photodegradation¹⁾ and microbial degradation²⁾ of butachlor were reported. In order to study the behavior and fate of this herbicide after its application in paddy rice fields and to seek further for the safe and more correct use, experiments have been done under the controlled laboratory conditions or in the field situation. Experiments on the stability of butachlor in different buffer solutions ranging from pH 1 to 10, volatilization from 0.05 M CaCl₂ solution, adsorption on soil at different temperature, leaching experiments with 4 different soil columns, uptake by rice plants and residues in the nutrient solution and the effect on the growth of *Chlorella vulgaris* were conducted at laboratory. Field experiments were performed during 2nd crop from Aug. 2 to Sept. 4, 1977, and 1st crop from Mar. 3 to Apr. 5, 1978 at Hsinchu District Agricultural Improvement Station, Hsingchu, Taiwan, for their actual dissipation status in paddy rice fields. Moreover, water samples were collected at the drainage ditch nearby paddy rice fields where the areas were treated with butachlor granules from northern part, central part and southern part of Taiwan during Jan. to Apr., 1978, and

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analyzed for their butachlor residues.

Very little information has been published on the degradation and dissipation of butachlor in soils, water and rice plants. Beestman and Deming³⁾ reported that the half life of butachlor in viable soil (Ray silt) was found to be 11.4 ± 0.3 days. They conducted the research work on dissipation rates of this herbicide under field conditions and to quantify the contributions of microbial decomposition, chemical breakdown, volatilization, and leaching. In our previous report,²⁾ the half life of Tainan silt loam was also demonstrated to be about 11 days with non-autoclaved soil. It was concluded that the soil microbes may play an important role in the degradation of butachlor in soils.

MATERIALS AND METHODS

1. Materials

Pure butachlor of 99.6% purity was obtained from Monsanto Co., St. Louis, Mo., U.S.A. Five % butachlor granule (Machete 5G) used in field experiments was a commercial product in Taiwan. Hsinchu silty clay and Tainan silt loam with clay 37% and 21%, silt 48% and 60%, sand 15% and 19% and organic matter 3.46% and 1.54%, and had a pH of 6.3 and 7.2 respectively were used in this study. Pure acetone and benzene were used after identifying no detectable impurities by *Ecd*-GC. *Chlorella vulgaris* ATCC 9765 was used in this experiment.

2. Apparatus

Ecd gas chromatography was performed through the experiment with Shimadzu Gas Chromatograph Model GC-5A type. The glass column (2 m \times 3 mm ID) with 5% OV-17 coated on 60/80 mesh Chromosorb W was employed. Operating temperatures were as follows: injection port, 230°C; column, 220°C; detector, 300°C. Nitrogen at a flow rate of 50 ml/min was used as a carrier gas. Shimadzu double beam spectrophotometer UV-200S was used for the measurement of chlorophyll.

3. Analyses

The water sample (20 or 50 ml) was treated by adding 10% NaCl solution to obtain a final concentration of 1% NaCl and then extracted

with 2 portions of benzene from aqueous phase. After drying with anhydrous Na_2SO_4 , an aliquot of benzene was analyzed by *Ecd*-GC. The soil sample (about 50 g) in 250-ml flask was extracted by three 50-ml portions of acetone on a shaker at 156 rpm for 30, 15 and 15 min respectively. Acetone extracts were separated from soil samples by centrifuger at 3,000 rpm for 10 min. It was then evaporated on a rotary evaporator below 40°C, and the residue was analyzed in a same manner as water sample. The shoot and root were analyzed separately for the analysis of rice plants. After washing plants with distilled water and then with acetone, it was homogenized in a mortar with 10 ml of acetone thrice. The acetone extracts were filtered through Whatman No. 2 filter paper and analyzed in a same way as the soil acetone extracts.

4. Laboratory Tests

Stability of butachlor in different pH buffer solutions were studied with various pH buffer solutions containing 2 ppm of butachlor. The solutions were stocked in a 1 l flask with rubber stopper at room temperature and analyzed periodically. The buffer systems are as follows: pH 1, KCl-HCl, pH 4, $\text{KHC}_6\text{H}_4(\text{COO})_2\text{-HCl}$, pH 6, $\text{KH}_2\text{PO}_4\text{-NaOH}$, pH 8, Borax-HCl and pH 10, Borax-NaOH⁴⁾.

Tests of volatilization from water influenced by temperature were carried out with a 250-ml flask containing 100 ml of 6.87 ppm butachlor in 0.05 M CaCl_2 solution. The flask was held on an water bath and aerated with an air stream (1,470 ml/min) by use of a fritted glass bubbler immersed in the solution. After 2 days, the vapor of water and butachlor collected in benzene trap were analyzed.

For the adsorption isotherm measurements, 10 g of oven-dried soils, which were air dried and sieved to pass through a 2-mm sieve, were placed in 50 ml of 0.05 M CaCl_2 solution containing butachlor at the desired amount. The soil-water suspension in 250-ml flask with a rubber stopper was agitated continuously for 3 hr on a shaker (156 rpm) at 24°C. The soil suspension was then centrifuged at 3,000 rpm for 10 min. An aliquot of the supernatant was analyzed. Butachlor was calculated from the difference between the original and equi-

librium concentration in supernatant and expressed in μg butachlor adsorbed per gram of soil. The amount removed from solution was considered to be adsorbed by soils. The effect of temperature on adsorption was performed with Tainan silt loam at 20, 30 and 40°C.

Leaching of butachlor on soil columns were studied with 4 glass columns at 24°C. The bottom of column was closed with glass wool and a rubber stopper with a glass tube as an outlet. Columns were inuniformly packed with oven-dried Tainan silt loam and were surface-treated with 1 ml of acetone solution containing different amounts of butachlor. After acetone was evaporated, the column was saturated with distilled water for 1 day. The herbicide was leached through the column by distilled water at different leaching rates. Two days after leaching, each soil column were sliced into some segments corresponding to each layer of depth and the residue of butachlor was determined.

Indica type rice seedlings grown in sand culture for 2 weeks were used for the study of uptake by rice plants. Nutrient solution containing different amounts of butachlor ranging from 0 to 2 ppm were used. Four seedlings were transplanted to a 420-ml glass pot filled with 400 ml of the nutrient solution and covered with black sheet to exclude from light. After cultivating for 20 days, fresh weight of shoot and root were measured and residue of butachlor in the nutrient solution was determined.

The *Chlorella vulgaris* was previously cultured in M-4N medium (KNO_3 5 g, K_2HPO_4 1.25 g, $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ 2.5 g, $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ 0.003 g, EDTA-Na 0.003 g, glucose 10 g and A_5 solution 1 ml in 1,000 ml H_2O). The A_5 minor element solution was composed of H_3BO_3 2.86 g, $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ 1.81 g, $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ 0.22 g, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ 0.08 g, Na_2MoO_4 0.021 g and conc. H_2SO_4 1 drop in 1,000 ml H_2O) at 30°C on a rotary shaker with 200 rpm under 600 lux light intensity for 4 days in the early log phase. After adding different amounts of butachlor for 2, 4 and 7 days, the cells in 10 ml chlorella suspension were centrifuged and the chlorophyll was extracted with 5 ml of a mixture of methanol and chloroform (2 : 1 v/v). It was then diluted to 10 ml and the

optical density at 652 nm was determined.

5. Field Experiments

The field experiments were performed during 2nd crop from Aug. 2 to Sept. 4, 1977 and 1st crop from Mar. 3 to Apr. 5, 1978 at Hsinchu District Agricultural Improvement Station, Hsinchu, Taiwan. The paddy field was 0.06 ha in area. Japonica type (Hsinchu No. 56) rice seedling was used. The field was treated by the conventional method with 5% Machete granule (1.5 kg butachlor/ha) after transplanting the rice seedlings for 3 days. The water, soil (0-3, 3-6, and 0-6 cm depth) and plant samples from the paddy field were collected and analyzed for the residues of butachlor before 1 day and after 0, 1, 2, 4, 8, 16 and 32 days after the application of the herbicide. Sampling was made after about 1 hr of the application on 0 day.

Survey of residue in the drainage ditch was done in the northern part (Hsinchu district), central part (Taichung district) and southern part (Pington district) of Taiwan during 1st crop from Jan. to Apr., 1978. The water samples were collected before the water surface without filtration from the drainage ditch nearby paddy fields where the areas were generally treated with butachlor granule about 3 days to 1 week before the 1st sampling. Second and 3rd sampling were made from the same spots as in the 1st sampling. The water samples were stocked in a polyethylene bottle and analyzed as soon as possible.

RESULTS AND DISCUSSION

The high recovery of butachlor in various buffer systems indicated that butachlor was very stable at all five given pH values (Table 1). Only a trace of 2-chloro-2',6'-diethylacetanilide was detected by *Ecd*-GC in pH 1 buffer solution on the later period (103 days). Hargrove and Merkle²³ had also pointed out that the acidic decomposition occurred in some extreme conditions such as in the soil at 0% relative humidity (38 or 46°C) or in 5N-aqueous HCl in the case of alachlor [2-chloro-2',6'-diethyl-N-(methoxymethyl)acetanilide, Lasso®]. However these conditions rarely happened in fields.

The volatilization of butachlor from 0.05 M

Table 1 Stability of butachlor in various pH buffer solutions.

Date	Time (day)	Butachlor recovered (%)				
		pH 1	pH 4	pH 6	pH 8	pH 10
Dec. 16 (1977)	0	97	96	98	96	96
Dec. 20	4	99	92	96	103	101
Dec. 24	8	92	88	97	97	92
Jan. 3 (1978)	18	85	91	90	94	93
Jan. 13	28	99	101	99	109	106
Jan. 23	38	96	93	95	106	109
Feb. 14	58	90	96	100	105	106
Feb. 31	103	85	88	96	96	100

Table 2 Volatilization of butachlor from 0.05 M CaCl₂ solution at different temperature.

Temperature (°C)	Evaporation rate of water ($\times 10^{-3}$ ml/cm ² /hr)	Loss of butachlor		Amount of butachlor trapped (μ g)
		(μ g)	(%)	
21.5	3.0	31	4.5	1.0
30	15.7	105	15.3	8.3
40	29.9	206	30.0	9.8

CaCl₂ solution was significantly affected by the temperature (Table 2). It was found that an approximately parallel relationship existed between the loss of the compound and the evaporation rate of water. In fields, the evaporation rate of water, 16×10^{-3} ml/cm²/hr, was generally found in summer days from our preliminary trials. Therefore, volatilization of butachlor from water surface seemed to be an important route of dissipation in hot weather. Beestman and Deming³⁾ reported that volatilization losses of butachlor from continuously moist soil under 21°C, 3.2 kph air stream was 3 to 6 times greater than volatilization from air-dry soils and significant volatilization losses would occur from wet, exposed soil under windy conditions.

Adsorption isotherms for butachlor on soils at 1 : 5 soil/solution ratio are shown in Fig. 1. Values for x/m vs. C were plotted on a log-log scale according to the empirical Freundlich relationship,⁶⁾

$$x/m = kC^{1/n}$$

where x/m is the amount of butachlor adsorbed per unit weight of adsorbent (μ g/g), C is the equilibrium concentration (μ g/ml) and k and n are constants characteristic of each slurry system. The constants k and n were estimated by calculation. The Freundlich constant k is

equal to the amount of herbicide adsorbed in μ g/g in equilibrium with an unit concentration of the herbicide and therefore is taken as an index of adsorption. Here, Tainan silt loam ($k=17.5$) with lower clay and organic matter content showed the less tendency to adsorb butachlor than Hsinchu silty clay loam ($k=54.5$)

Temperature gave a significant effect on adsorption of butachlor by soil. Elevation of

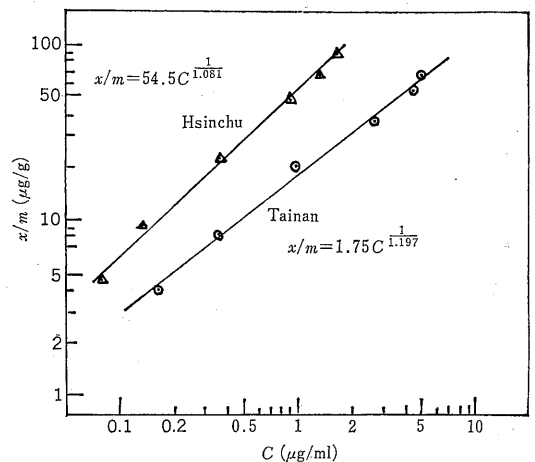


Fig. 1 Freundlich adsorption isotherms for butachlor with two soils.

Table 3 Adsorption of butachlor on Tainan silt loam at different temperature.

Temperature (°C)	Equilibrium concentration in 0.05 CaCl ₂ soln. (ppm)*	Butachlor adsorbed (μg/g)
20	1.71	41.5
30	2.85	35.8
40	5.04	24.8

* Original concentration of butachlor is 10 ppm.

temperature from 20 to 40°C generally resulted in decreased adsorption (Table 3).

Leaching of butachlor in soil columns resulted in a placement of the compound at varying depth in the soil (Table 4). The data indicated

that the leaching was correlated with leaching rates and amounts of butachlor applied. In column A, the applied rate was about 3 times of the recommended rate and with an amount of water equivalent to 110 mm of rainfall. It was found that an insignificant amount of butachlor was leached to layers below 2 cm of depth. Beestman and Deming³⁾ also concluded that leaching did not contribute to dissipation.

The growth of rice seedlings seemed to be inhibited at the concentration of 0.5 ppm or more in the nutrient solution (Table 5). The more the accumulation of butachlor in root, the more the growth of rice plants was inhibited. In fact, the susceptibility of plants to herbicide is several folds higher when plants

Table 4 Leaching of butachlor on soil columns.

Soil depth (cm)	Butachlor recovered (ppm)*			
	Column A	Column B	Column C	Column D
0-2	9.63	26.94	4.00	5.73
2-4	0.45	31.47	3.69	5.48
4-6	0.40	26.40	2.01	0.80
6-8	0.49	8.30	2.14	0.38
8-10	0.28	2.95	1.75	0.12
10-12	<0.001	0.65	1.20	0.03
12-14	<0.001	0.20	0.72	<0.001
14-16	<0.001	0.20	0.34	<0.001
16-18	<0.001	0.08	0.54	<0.001
18-20	<0.001	<0.001	0.19	<0.001
20-22	<0.001	<0.001	0.11	<0.001
22-24	<0.001	<0.001	0.06	<0.001
Rate applied (kg/ha)	4.19	36.23	8.38	8.38
I.D. × length (cm × cm)	3.90 × 34.0	3.75 × 33.5	3.90 × 34.9	3.90 × 33.5
Leaching rate (mm/hr)	2.32	8.63	11.56	8.04
Bulk density (g/cm)	1.278	1.224	1.259	1.312

* Based on the wet weight.

Table 5 Growth of rice plant and residue in the nutrient solutions cultivating for 20 days.

Concentration	0 ppm		0.05 ppm		0.1 ppm		0.5 ppm		1.0 ppm		2.0 ppm	
	Fresh wt(g)	Residue (ppm)*	Fresh wt(g)	Residue (ppm)*	Fresh wt(g)	Residue (ppm)*	Fresh wt(g)	Residue (ppm)*	Fresh wt(g)	Residue (ppm)*	Fresh wt(g)	Residue (ppm)*
Nutrient solution	—	<0.001	—	<0.001	—	<0.001	—	0.10	—	0.15	—	0.78
Root	0.033	<0.001	0.036	<0.001	0.036	<0.001	0.034	9.41	0.028	16.43	0.026	111.54
Shoot	0.384	<0.001	0.398	<0.001	0.376	<0.001	0.284	0.60	0.239	0.75	0.168	5.83

* Based on the fresh weight.

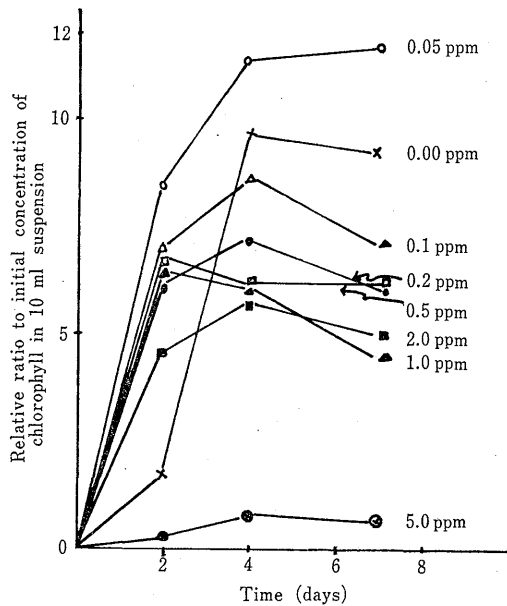


Fig. 2 Effect of butachlor on the growth of *Chlorella vulgaris*.

are grown in culture solution than in clay soil in the case of alachlor.⁷⁾ The losses of buta-

chlor in the nutrient solutions were found to be remarkable, probably due to the volatilization, photodecomposition or by microbial degradation from the solution.

The growth of *Chlorella vulgaris* seemed to be inhibited at the concentration of 0.1 ppm or more after cultivated for 4 days, but some stimulative effects were demonstrated in the initial 2 days at the concentration below 2 ppm. In the lower concentration at 0.05 ppm, stimulative effect on growth was observed throughout the experiment (Fig. 2).

In field experiments, some differences were observed between the results of 1st crop and 2nd crop (Table 6). Analyses of water samples from treated field showed no butachlor prior to application but a maximum concentration of 2.16 ppm was obtained in 0 day from 2nd crop and 0.30 ppm in 1 day from 1st crop. The half lives of butachlor dissipated from field water were found to be about 0.8 day in 2nd crop and 5.5 days in 1st crop. The residue of the herbicide in the soil layer of 3–6 cm depth was remarkably smaller than that of the layer of 0–3 cm depth in both crops,

Table 6 Residues of butachlor in the paddy field.

Date	Time (day)	Water		Soil (ppm)*				Rice plant (ppm)**			
		(ppm)	pH	0–3 cm	3–6 cm	0–6 cm	pH	Shoot	Root	Dried wt (g/plant)	
2nd crop (1977)											
Aug.	2	<0.001	7.4	<0.001	<0.001	<0.001	6.0	<0.001	<0.001	0.05	
Aug.	3	2.16	7.6	9.17	0.58	4.59	6.5	31.20	<0.001	0.05	
Aug.	4	0.46	7.8	2.00	0.15	3.44	6.5	12.74	0.81	0.09	
Aug.	5	0.24	8.3	0.87	0.10	2.38	6.3	0.46	0.46	0.10	
Aug.	7	0.09	7.7	0.44	0.06	0.23	6.6	<0.001	<0.001	0.09	
Aug.	11	0.02	8.4	0.23	0.12	0.45	6.4	<0.001	<0.001	0.11	
Aug.	19	0.02	7.4	0.17	0.05	0.07	6.9	<0.001	<0.001	1.11	
Sept.	4	0.02	7.6	0.30	0.06	0.07	6.5	<0.001	<0.001	3.95	
1st crop (1978)											
Mar.	3	<0.001	6.8	<0.001	<0.001	<0.001	6.6	<0.001	<0.001	0.03	
Mar.	4	0.29	6.7	4.00	0.51	0.76	6.1	2.03	1.62	0.03	
Mar.	5	0.30	6.6	2.76	0.24	1.07	6.0	2.54	2.88	0.03	
Mar.	6	0.25	6.5	1.72	0.06	0.33	6.0	3.43	2.86	0.03	
Mar.	8	0.19	6.3	1.17	0.06	0.38	6.0	2.98	2.37	0.03	
Mar.	12	0.11	7.0	2.23	0.48	2.43	6.7	0.44	5.98	0.04	
Mar.	20	0.04	7.1	0.53	0.06	1.09	6.4	0.74	0.93	0.07	
Apr.	5	0.01	7.0	1.25	<0.001	0.50	6.4	<0.001	<0.001	0.22	

* Based on the oven-dried weight.

** Based on the air-dried weight.

stressed again that the movement of butachlor in paddy fields was negligible. The longer persistence of butachlor in soil and in rice plant in 1st crop than in 2nd crop was found to be similar to the case of field water. More amounts of butachlor found in shoot than in root in 2nd crop may be resulted from the higher concentration of butachlor in field water. However, this phenomenon was not found in 1st crop. The difference of the results between 2 crops may be able to ascribed to the response of quite a different climate between 2 crops. During the period of experiments, a hot and shiny weather was observed in 2nd crop, whereas relatively cooler and rather cloudy weather showed a slower degradation and dissipation rates in 1st crop. In our preliminary trials, only 20% of butachlor was reserved when 100 ml of field water containing 0.29 ppm of butachlor in Petri dish was exposed to sunlight at 25–35°C for 1 day. In our previous paper,¹⁾ it was reported that photodecomposition of butachlor, as thin film on glass under UV light was very fast.

The half life was found to be about 1.5 hr. Photodecomposition of alachlor in flooded soils under sunlight was found to be more easy than on glass surface or in air-dry soils.⁹⁾ Therefore, it might be able to conclude that photodecomposition, volatilization and microbial degradation of butachlor were the major routes of dissipation of the herbicide from paddy fields in summer days, whereas microbial decomposition shown by Beestman and Deming³⁾ seemed to be the major avenue in cold and cloudy days.

The residues of butachlor in the water of drainage ditch nearby paddy fields treated extensively with this herbicide about 3 days to 1 week before 1st sampling were found to be less than 0.06 ppm and disappeared about in 1 month (Table 7).

From above evidence, the degradation and dissipation of butachlor in rice fields seemed to be rather easy. It might be able to conclude that the application of butachlor in rice fields may not cause a serious problem on the environmental pollution.

Table 7 Residues of butachlor in the water of drainage ditch.

Sample No.	Location	1st sampling		2nd sampling		3rd sampling		Days after application of herbicide for 1st sampling
		Date	Residue (ppm)	Date	Residue (ppm)	Date	Residue (ppm)	
1	Pingtung	Jan. 26	0.013	Mar. 24	<0.001			3
2	Pingtung	Jan. 26	0.031	Mar. 24	<0.001			3
3	Pingtung	Jan. 26	0.012	Mar. 24	<0.001			10
4	Pingtung	Jan. 26	0.032	Mar. 24	<0.001			7
5	Taichung	Mar. 18	0.022	Apr. 18	≤0.001			3–7
6	Taichung	Mar. 18	0.060	Apr. 18	≤0.001			7
7	Taichung	Mar. 18	0.008	Apr. 18	≤0.001			7
8	Taichung	Mar. 18	0.047	Apr. 18	0.003			5
9	Taichung	Mar. 18	0.002	Apr. 18	≤0.001			3
10	Taichung	Mar. 18	0.002	Apr. 18	0.002			10
11	Taichung	Mar. 18	0.017	Apr. 18	≤0.001			7
12	Taichung	Mar. 18	0.010	Apr. 18	≤0.001			7
13	Hsinchu	Apr. 1	0.017	Apr. 8	0.006	Apr. 29	≤0.001	5–7
14	Hsinchu	Apr. 1	0.026	Apr. 8	0.010	Apr. 29	0.001	5–7
15	Hsinchu	Apr. 1	0.008	Apr. 8	0.003	Apr. 29	≤0.001	5–7
16	Hsinchu	Apr. 1	0.020	Apr. 8	0.014	Apr. 29	0.004	5–7
17	Hsinchu	Apr. 1	0.008	Apr. 8	0.003	Apr. 29	≤0.001	5–7
18	Hsinchu	Apr. 1	0.016	Apr. 8	0.009	Apr. 29	0.001	5–7
19	Hsinchu	Apr. 1	0.006	Apr. 8	0.003	Apr. 29	≤0.001	7
20	Hsinchu	Apr. 1	0.004	Apr. 8	0.002	Apr. 29	≤0.001	7

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要 約

除草剤ブタクロールの水田における分解および消失

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除草剤ブタクロール(マーシュット)を用いて実験室で行なった実験では、ブタクロールの分解は水溶液において異なる pH では影響を受けず、また湛水状態の土壌中では温度が吸着に著しく影響することがわかった。0.05 M CaCl₂ 溶液中における蒸散も温度が著しく影響する。土壌カラムを用いて行なった実験ではブタクロールの溶脱は水の流速と薬剤の使用量と関係がある。培養液におけるイネの生長は 0.5 ppm, *Chlorella vulgaris* の生長は 0.1 ppm の濃度で阻害を受けた。

一般の使用法で行なった第二期作(8月)における圃場試験では使用当日水田の水に最高量 2.16 ppm を認めたが速やかに減少し4日後には 0.1 ppm 以下となった。水田表土(0~3 cm)にも使用当日最高量 9.17 ppm 存在したが4日後には 0.5 ppm 以下となった。イネ(茎葉部)におけるブタクロールの吸収量は使用当日最高量 31.2 ppm を示したが4日後には測定できなかった。第一期作(3月)における圃場試験では若干異なる結果が得られたが恐らく気象条件が著しく異なる結果によるものであらうと思われる。ブタクロールを全面的に使用した水田附近の排水溝水(使用後3~7日に採取)における残留量を調べた結果は何れも 0.06 ppm 以下であり、約1カ月後にはほとんど検出限界値(0.001 ppm)付近またはそれ以下であった。

水田におけるブタクロールの分解および消失はかなり容易でありブタクロールの水田における使用は環境の汚染に大きな影響を及ぼすことがないものと思われる。