Controlled Release of Oxyfluorfen from the Variously Complexed Formulations.

IV. Effect of Water Level Depths on the Activity of Selected Formulations

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數種의 結合劑型으로 부터 Oxyfluorfen의 放出抑制硏究.

IV. 灌漑甚에 따른 選拔劑型 Oxyfluorfen의 藥害·藥效評價

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ABSTRACT

Seven oxyfluorfen formulations were tested for control of 8 weed species and rice injury under four different water depths with various ages of rice seedlings. Among formulations tested, rice injury was slight by formulations of Elvan, Coal Slag, Chitosan and Bentonite B under 0 cm or shallow water depths, and by those of Elvan and Coal Slag under deep water conditions. Weed control was high by Bentonite A and B, and Chitosan, and was low by Elvan, Coal Slag and Sand coated oxyfluorfen, if the target weeds of oxyfluorfen are annual species, further development of Elvan, coal slag, chitosan and Bentonite A would be controlled to increase control efficacy or to decrease rice injury.

Key words : Controlled release, oxyfluorfen, complexed formulations, water depths, compatibility.

INTRODUCTION

Rice herbicides had begun to use in the late of 1960's in Korea. At first a herbicide nitrofen was used, which is a herbicide of diphenylether family including oxyflurofen. The principle of preemergence treatments by adsorption was obtained by applying nitrofen to the soil surface(11). Also, because the herbicide released into water showed the contact injury on leaf sheath of rice plants, the degree or appearing injury would be increased or decreased depending upon water depths in rice fields (4). Although biological activity within plants may be different(6), oxyflurofen and nitrofen are expected to have similar modes of acton as diphenylether herbicides. Besides this, many reports were published on the effects of water depths for crop injury of herbicides including bensulfuron, dimepiperate and pretilachlor on injury responses of young rice seedlings when water depths varied.

Therefore, the objective of this research was to evaluate effects of oxyflurofen formulations selected in the previous reports(1, 15) on growth of rice and various weeds when water depths varied. Of course the effect of water depths may be dependent upon water solubility(1, 15), adsorption to soil surface (12), growth stage of plants(16), water quality especially water pH or turbidity(5) or leakage of water(14). Also, growing season and application time are related to the appearance of injury(5, 17). In this study, water was kept all the time in appropriate depths and was not leaked throughout the experiment in a greenhouse.

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MATERIALS AND METHODS

Like in the previous report(3), experiments were conducted using six formulations of oxyflurofen including Bentonite A, Bentonite B, Chitosan, Coal slag, Elvan and Zeolote in a greenhouse, and sand-coated oxyfluorfen 1G which is a product of Rohm and Hass, U.S.A. was included to compare with those described above. The greenhouse had temperatures 26±3 and 18±1℃ for day and night with day length of 10h, respectively.

A Japonica type of rice cultivar 'Jangsung' was used for injury test. This cultivar was direct-seeded and transplanted with 8, 22 and 32 day old seedlings and a Hybrid type of rice cultivar 'Samgang' was used only on direct-seeding and 8 day old seedlings. Weed species to test control efficacy contained 4 annuals including *Echinochloa crus-galli*, *Monochoria vaginalis*, *Cyperus difformis* and *Scirpus juncoides*, and 4 perennials including *Eleocharis kuroguwai*, *Sagittaria pygmaea*, *Potamogeton distinctus* and *Cyperus serotinus*. Seeds and propagules of annual and perennial weeds were planted in the same way as the previous report[3].

There were no leakage of water in the trays. Water was kept 0, 1, 3, 5cm deep. Each formulation of oxyfluorfen was applied at a rate of 40g/ha (double rate) with three replications. During the experiment, the general practices, evaluation of rice injury and control efficacy were the same as for the previous report(3).

RESULTS AND DISCUSSION

I. PHYTOTOXYCITY

Table 1 shows the visual ratings of injury at 7, 14, 28, and 40 days after rice transplanting when 7 oxyfluorfen formulations were applied to rice direct-seeded and transplanted with 8, 25 and 35 day-old seedlings under the conditions of different water depths of 0, 1, 3 and 5cm. Injury was increased with increased water depths regardless of formulations, and was higher for Hybrid cultivar than for Japonica cultivar. Direct-seeded rice died mostly within 14 days after application. Eight-day old seedlings showed considerable symptoms of bleach in leaf sheath from 7-days after application and symptoms were recovered at 40 days after transplanting. However, crop injury for 25 and 35 day-old seedlings was increased as water depths increased 3 to 5cm deep, and was slowly recovered with time. This result seggests that as shown in the previous results[3], rice injury by oxyfluorfen may be increased as age of seedlings is low and as water depths are increased because younger seedlings have relatively small contact areas of oxyfluorfen and contact areas of rice plants is increased with deeper water levels.

This indicates that use of oxyfluorfen could not be applicable to rice direct-seeded and transplanted with 8 day-old seedlings, but could be applicable to rice transplanted with 25 and 35 day-old seedlings when water is maintained less than 3cm deep. In addition, it was judged that Japonica type cultivar was safer than Hybrid cultivar because height of hybrid cultivar was shorter than Japonica cultiver during the nursery period. Among formulations tested, Elvan, Bentonite B, Chitosan, Coal slag and Zeolite showed promise with slight injury when water depths of 1 or 3cm, but when water was flooded up to 5cm deep, injury was inereased for even adult seedling. Under deep water conditions, Bentonite A, Chitosan, Zeolite and Bentonite B showed relatively high injury, but Elvan and coal slag showed slight injury.

Zeolite, Bentonite, Elvan and Coal slag have different spatial lattices with different inorganic materials, so that there may be interactions between molecular size of oxyfluorfen and spatial lattice of Coal slag(3).

The visual phytotoxicity was corresponded to the variations of plant height at 40 and 50 days after transplanting (Table 2), and variations of fresh weight at 50 days after transplanting (Table 3). In general, plant height and fresh weight production were greater for Japonica cultivar than for hybrid cultivar. Direct-seeded rice and transplanted rice with 8 day old seedlings showed good growth when water was kept 0 cm deep than when flooded, while growth of 25 and 35 day old seedlings was relatively low when unflooded. However, plant height was not affected among formulations while Bentinite B,

Table 1. Change in visual rates(0-9 ; Check=0) on rice phytotoxicity as affected by various oxyflurofen formulations under different water levels.

Formulations	7DAT[1/]				14DAT				28DAT				40DAT			
	S[2/]	8[3/]	25[4/]	35[5/]	S	8	25	35	S	8	25	35	S	8	25	35
	..... WATER DEPTH : 0cm															
Bentonite A	1(1)	2(3)	1	1	1(2)	3(3)	1	1	1(2)	3(4)	2	2	0(1)	2(4)	2	1
Bentonite B	0(0)	2(2)	1	1	1(1)	3(3)	1	0	1(2)	2(4)	2	1	0(1)	1(3)	1	0
Chitosan	0(0)	1(2)	1	1	1(1)	1(1)	0	0	1(1)	1(2)	1	0	0(0)	1(1)	1	0
Coal slag	0(0)	2(2)	1	1	1(1)	2(3)	0	0	0(0)	1(1)	1	0	0(0)	1(0)	1	0
Elvan	0(0)	2(2)	1	1	0(0)	0(1)	0	0	0(0)	1(1)	0	0	0(0)	0(0)	0	0
Zeolite	0(0)	1(2)	1	1	0(0)	1(1)	0	0	0(1)	1(1)	1	0	0(0)	1(1)	1	0
Sand	1(1)	2(2)	1	1	1(1)	2(3)	1	1	1(3)	2(2)	1	1	0(1)	2(3)	1	1
	..... WATER DEPTH : 1cm															
Bentonite A	1(1)	2(2)	1	1	8(9)	1(1)	1	1	9(9)	2(2)	1	1	9(9)	2(2)	1	1
Bentonite B	1(1)	2(2)	1	1	8(9)	1(2)	1	0	9(9)	1(1)	1	1	9(9)	1(1)	1	0
Chitosan	1(1)	2(2)	1	1	9(9)	1(2)	0	0	9(9)	1(1)	1	0	9(9)	1(1)	1	0
Coal slag	1(1)	2(2)	1	1	9(9)	2(2)	0	1	9(9)	1(1)	0	0	9(9)	0(1)	0	0
Elvan	0(0)	1(1)	1	1	7(8)	1(1)	0	0	9(9)	0(1)	0	0	9(9)	0(0)	0	0
Zeolite	1(1)	2(3)	1	1	9(9)	2(4)	1	1	9(9)	1(1)	1	0	9(9)	1(1)	1	1
Sand	1(1)	2(2)	1	1	9(9)	2(4)	1	1	9(9)	1(1)	1	0	9(9)	2(1)	1	1
	..... WATER DEPTH : 3cm															
Bentonite A	1(1)	3(4)	2	1	9(9)	3(4)	2	1	9(9)	3(4)	1	1	9(9)	3(3)	1	1
Bentonite B	1(1)	2(3)	1	1	9(9)	2(3)	2	0	9(9)	2(3)	1	1	9(9)	2(3)	1	1
Chitosan	1(1)	2(3)	1	1	9(9)	2(4)	1	0	9(9)	2(2)	1	1	9(9)	1(2)	1	0
Coal slag	1(1)	1(3)	2	1	9(9)	1(1)	1	0	9(9)	1(2)	1	0	9(9)	1(1)	0	0
Elvan	1(1)	1(2)	1	1	9(9)	0(0)	0	0	9(9)	1(1)	0	0	9(9)	0(0)	0	0
Zeolite	1(1)	3(4)	2	1	9(9)	3(4)	1	1	9(9)	3(3)	1	1	9(9)	0(2)	1	0
Sand	1(1)	2(3)	1	1	9(9)	2(2)	2	0	9(9)	3(3)	1	1	9(9)	2(2)	1	0
	..... WATER DEPTH : 5cm															
Bentonite A	1(1)	7(8)	5	3	9(9)	7(9)	3	1	9(9)	4(9)	3	2	9(9)	7(9)	4	2
Bentonite B	1(1)	6(8)	3	2	9(9)	5(7)	2	1	9(9)	3(9)	2	1	9(9)	3(6)	1	1
Chitosan	1(1)	4(5)	3	2	9(9)	7(8)	2	1	9(9)	1(9)	1	1	9(9)	3(4)	3	0
Coal slag	1(1)	3(5)	2	1	9(9)	3(4)	2	1	9(9)	1(9)	1	1	9(9)	2(2)	1	0
Elvan	1(1)	1(4)	1	1	8(8)	2(8)	1	0	9(9)	1(9)	1	0	9(9)	1(5)	1	0
Zeolite	1(1)	5(8)	2	1	8(8)	2(8)	1	1	9(9)	2(9)	1	1	9(9)	3(9)	2	1
Sand	1(1)	2(2)	1	1	9(9)	2(4)	1	1	9(9)	3(7)	2	1	9(9)	4(2)	3	2

ABB.) 1/ : Day assessed(days after transplanting), 2/ : Seeds, 3/, 4/, 5/, 6/ : Seedling ages(days after seeding), respectively. Number in parenthesis indicates the data from Hybrid rice variety.

Elvan and Zeolite produced higher fresh weight than Bentonite A, Coal slag and Chitosan. At 40 and 50 days after transplanting plant height of rice was not affected consistently among formulations because injury was recovered and new leaf are emerged at that time, but variations of fresh weight among formulations were reduced at 50 days after transplanting due to recovery of injury. Similar results were reported by the authors(2, 3) and Murphy *et al.* (13) with an acifluorfen study.

II. Herbicidal Efficacy.

Weed control of oxyfluorfen was greatly affected by differences in water depths. *Monochoria* and umbrellaplant were almost completely controlled by 50 days after treatment regardless of oxyflurofen formulations or wate depths. Control of barnyardgrass was decreased with decreased water depths, and was excellent in water more than 3cm deep. This was due to high germination and growth of bardyardgrass in water depths of 0 or 1cm because barnyardgrass reguired high oxygen for germination(9). On the other hand, control of bulrush was decreased 40 to 50 days after transplanting in shallow water depths because bulrush required low oxygen for germination(7). This response was marked

Table 2. Change in plant height of rice as affected by various oxyfluorfen formulations under different water levels. (Unit : cm)

Formulations	S[1]		8[2]		25[3]		35[4]	
	40[5]	50[6]	40	50	40	50	40	50
	WATER DEPTH : 0cm							
Bentonite A	18(4)	28(13)	21(6)	26(11)	19	30	23	29
Bentonite B	14(2)	27(13)	19(7)	26(11)	22	28	21	31
Chitosan	20(7)	28(11)	22(10)	30(13)	20	27	23	28
Coal slag	19(8)	28(13)	26(8)	38(11)	24	21	24	28
Elvan	23(8)	34(14)	24(7)	32(13)	17	31	26	32
Zeolite	16(5)	31(12)	21(9)	29(11)	21	26	27	31
Sand	16(3)	30(12)	23(11)	32(16)	21	27	26	29
Check	17(7)	28(12)	22(10)	29(15)	13	32	21	26
	WATER DEPTH : 1cm							
Bentonite A	0(0)	0(0)	22(9)	31(14)	23	32	23	34
Bentonite B	0(0)	0(0)	25(11)	33(18)	22	29	30	35
Chitosan	0(0)	0(0)	21(10)	31(14)	24	29	27	34
Coal slag	0(0)	0(0)	23(10)	32(17)	26	33	26	32
Elvan	0(0)	18(0)	26(8)	38(14)	29	37	28	36
Zeolite	0(0)	0(0)	24(10)	35(13)	14	33	25	32
Sand	0(0)	0(0)	24(9)	31(13)	21	30	25	33
Check	19(9)	22(16)	24(8)	32(14)	24	30	22	34
	WATER DEPTH : 3cm							
Bentonite A	0(0)	0(0)	17(8)	26(12)	21	27	24	30
Bentonite B	0(0)	0(0)	21(9)	30(15)	22	29	25	30
Chitosan	0(0)	0(0)	25(10)	30(15)	21	28	27	36
Coal slag	0(0)	0(0)	28(11)	31(16)	24	32	27	33
Elvan	0(0)	0(0)	25(12)	34(18)	25	31	26	34
Zeolite	0(0)	0(0)	20(9)	31(13)	23	31	23	31
Sand	0(0)	0(0)	23(11)	30(13)	23	28	28	33
Check	16(9)	20(10)	25(11)	32(17)	22	29	23	33
	WATER DEPTH : 5cm							
Bentonite A	0(0)	0(0)	25(0)	24(0)	24	33	29	37
Bentonite B	0(0)	0(0)	19(10)	30(15)	22	32	31	36
Chitosan	0(0)	0(0)	23(0)	32(0)	23	35	27	39
Coal slag	0(0)	0(0)	23(11)	39(15)	23	33	25	37
Elvan	0(0)	0(0)	27(8)	40(23)	25	35	29	35
Zeolite	0(0)	0(0)	22(0)	31(0)	25	37	28	39
Sand	0(0)	0(0)	25(11)	36(14)	26	33	27	34
Check	16(8)	20(10)	26(16)	34(17)	26	34	29	35

ABB) : Refer to Table 1.

in the treatments of Coal slag, Elvan, Zeolite and sand-coated oxyfluorfen ; however, Bentonite A, Bentonite B and Chitosan gave good control of barnyardgrass and balrush consistently regardless of germination habits.

Because arrowhead, a perennial species, requires low oxygen for germination and emerges late, all formulations of oxyfluorfen controlled arrowhead highly and consistantly in 0 cm water depth, but the control value was decreased 40 to 50 days after transplanting in water depth of 1cm or greater. Serotinus was not controlled in 0 cm water depth, but was controlled better with increased water depths because *Cyperus serotinus* probably emerged early and required low oxygen for emergence. Like arrowhead, pondweed emerged from the deep soil and required extremely low oxygen for emergence, but pondweed control was decreased with increased water depths. Formulations that gave high control values until 50 days after transplanting and showed increased control among formulations was probably due to difference in the rate of releasing active ingre-

Table 3. Variation in fresh weight(g) of shoots per plant at 50DAT as affected by various oxyfluorfen formulations under different water levels(Unit : g).

Formulations	WATER DEPTH : 0cm				WATER DEPTH : 1cm			
	S[1/]	8[2/]	25[3/]	35[4/]	S	8	25	35
Bentonite A	0.42(0.22)	0.58(0.30)	0.59	0.84	0(0)	0.63(0.43)	0.61	0.82
Bentonite B	0.49(0.20)	0.40(0.33)	0.58	0.70	0(0)	0.63(0.53)	0.65	0.90
Chitosan	0.52(0.30)	0.53(0.42)	0.60	0.70	0(0)	0.62(0.56)	0.62	0.78
Coal slag	0.59(0.36)	0.65(0.42)	0.48	0.67	0(0)	0.69(0.58)	0.68	0.72
Elvan	0.45(0.40)	0.60(0.42)	0.60	0.68	0.28(0)	0.77(0.53)	0.83	0.73
Zeolite	0.35(0.38)	0.52(0.52)	0.68	0.75	0(0)	0.74(0.56)	0.64	0.69
Sand	0.52(0.20)	0.61(0.44)	0.61	0.81	0(0)	0.68(0.63)	0.60	0.75
Check	0.38(0.30)	0.43(0.37)	0.67	0.60	0.46(0.3)	0.59(0.32)	0.59	0.69
	WATER DEPTH : 3cm				WATER DEPTH : 5cm			
Bentonite A	0(0)	0.46(0.45)	0.73	0.78	0(0)	0.47(0.17)	0.62	0.72
Bentonite B	0(0)	0.50(0.45)	0.63	0.78	0(0)	0.57(0.30)	0.61	0.88
Chitosan	0(0)	0.60(0.60)	0.63	0.73	0(0)	0.51(0.33)	0.60	0.76
Coal slag	0(0)	0.75(0.64)	0.68	0.79	0(0)	0.50(0.32)	0.62	0.73
Elvan	0(0)	0.71(0.77)	0.78	0.79	0.57(0)	0.57(0.62)	0.76	0.83
Zeolite	0(0)	0.68(0.56)	0.70	0.73	0(0)	0.67(0.38)	0.72	0.89
Sand	0(0)	0.67(0.46)	0.64	0.79	0(0)	0.51(0.30)	0.52	0.65
Check	0.71(0.43)	0.61(0.48)	0.73	0.76	0.38(0.31)	0.59(0.37)	0.54	0.62

ABB) : Refer to Table 1.

Table 4. Change in visual rates(0-9 ; Check=0) on weeding efficacy as affected by various oxyfluorfen formulations under different water levels.

Formulations	EC[1/]				MV[2/]				CD[3/]				SJ[4/]				SP[5/]				PD[6/]				CS[7/]			
	14[8/]	28[9/]	40[10/]	50[11/]	14	28	40	50	14	28	40	50	14	28	40	50	14	28	40	50	14	28	40	50	14	28	40	50
	WATER DEPTH : 0cm																											
Bentonite A	4	4	5	1	9	9	9	9	9	9	9	9	7	9	7	7	9	9	9	9	9	9	9	9	2	0	0	0
Bentonite B	1	4	3	0	7	9	9	9	9	4	8	9	9	4	6	8	9	9	9	9	9	9	9	9	0	0	0	0
Chitosan	2	4	2	0	9	9	9	9	9	9	9	9	6	5	6	7	7	8	8	9	4	9	8	9	4	1	1	0
Coal slag	0	2	2	0	9	9	9	9	9	9	9	9	5	5	7	7	9	9	9	9	6	9	9	9	1	0	1	0
Elvan	0	0	2	0	9	9	9	9	9	9	9	9	5	5	8	7	8	9	9	9	7	7	9	9	0	0	1	0
Zeolite	0	1	1	0	9	9	9	9	9	9	9	9	4	5	7	8	9	9	9	9	5	9	9	9	0	0	1	0
Sand	2	2	0	0	9	9	9	9	9	9	9	9	3	5	6	7	9	9	9	9	1	9	9	9	0	0	1	0
	WATER DEPTH : 1cm																											
Bentonite A	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9	9	7	9	9	8	7	3	8	8
Bentonite B	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	6	7	9	9	9	5	3	6	7
Chitosan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	8	9	9	9	6	4	8	7	6	6	0	6	6
Coal slag	9	7	7	9	9	9	9	9	9	9	9	9	9	9	8	8	9	9	8	7	7	2	6	8	4	2	7	6
Elvan	9	8	7	9	9	9	9	9	9	9	9	9	9	9	8	8	9	9	7	9	5	2	7	9	4	2	8	7
Zeolite	9	8	7	9	9	9	9	9	9	9	9	9	9	9	8	8	9	9	9	9	6	2	8	7	6	0	6	7
Sand	9	4	6	7	9	9	9	9	9	9	9	9	9	8	7	8	9	9	9	9	4	3	8	7	7	3	6	7
	WATER DEPTH : 3cm																											
Bentonite A	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	3	8	5	8	6	8	6
Bentonite B	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	3	7	6	9	3	8	8
Chitosan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	8	2	4	7	4	9	3	8	8
Coal slag	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	7	9	2	2	6	1	9	3	8	8	
Elvan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	2	7	3	9	2	8	8
Zeolite	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9	4	1	5	1	8	1	8	8
Sand	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	1	1	4	0	9	1	8	7
	WATER DEPTH : 5cm																											
Bentonite A	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	6	1	3	7	6	9	9	9	9
Bentonite B	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	7	5	4	8	8	9	8	9	8
Chitosan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	5	1	7	6	9	9	9	9
Coal slag	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	8	1	1	6	5	9	9	8	8
Zeolote	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	7	9	9	9	9	0	1	5	6	9	9	8	8
Elvan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	0	1	7	8	9	9	9	9
Sand	7	7	8	9	9	9	9	9	9	9	9	9	9	9	9	8	6	6	5	5	0	0	5	4	9	6	3	2

Abb.) 1/ : *Echinochloa crus-galli*, 2/ : *Monochoria vaginalis*, 3/ : *Cyperus difformis*, 4/ : *Scirpus juncoides*, 5/ : *Sagittaria pygmaea*, 6/ : *Potamogeton distinctus*, 7/ : *Cyperus serotinus*, 8/, 9/, 10/, 11/ : Assessed date(The days after application).

Table 5. Variation in fresh weight(g/pot) of emerged weeds at 50DAT as affected by various oxyflurofen formulations under different water levels.

Formulations	Annuals					Perennials				Total
	EC	MV	CD	SJ	%[1/]	SP	PD	CS	%[2/]	Efficacy(%)
	WATER DEPTH : 0cm									
Bentonite A	5.15	0	0.01	0.38	36.3	0	0	3.45	46.8	30.6
Bentonite B	7.06	0	0	0.05	18.3	0	0	3.45	46.8	18.5
Chitosan	7.84	0	0.11	0.30	5.2	0.42	0	3.66	37.0	4.9
Coal slag	8.50	0	0	0.35	1.7	0	0	2.55	60.5	12.0
Elvan	7.96	0.01	0.04	0.49	2.3	0.15	1.26	2.94	32.9	0.9
Zeolite	6.78	0	0	0.20	19.8	0	0	4.11	36.6	14.4
Sand	6.64	0	0	0.23	21.0	0	0	3.84	40.7	17.4
Check	7.64	0.23	0.40	0.43	0	0.45	3.06	2.97	0	0
	WATER DEPTH : 1cm									
Bentonite A	0	0.01	0	0.01	99.8	0	0.09	1.26	76.7	89.9
Bentonite B	0	0	0	0.01	99.9	0.21	0	1.47	71.0	87.6
Chitosan	0.93	0	0	0.03	87.7	0	2.22	0	61.7	76.7
Coal slag	1.86	0	0.03	0.07	75.0	0.27	0.42	1.69	58.9	68.1
Elvan	2.27	0	0	0.04	70.5	0.51	0.36	2.00	50.4	62.0
Zeolite	1.75	0	0	0.10	76.4	0	0.51	2.43	49.2	64.8
Sand	4.30	0	0	0.03	44.7	0	0.51	2.43	49.2	46.6
Check	7.40	0.19	0.05	0.19	0	1.23	0.72	3.84	0	0
	WATER DEPTH : 3cm									
Bentonite A	0	0	0	0	100.0	0	0.54	1.56	74.1	83.5
Bentonite B	0	0	0	0	100.0	0.03	0.39	0.33	90.7	94.1
Chitosan	0	0	0	0	100.0	0.18	0.63	0.75	80.7	87.7
Coal slag	0	0	0	0	100.0	0.42	1.65	0.15	72.6	82.5
Elvan	0	0	0	0.02	99.6	0	0.84	0.72	80.7	87.6
Zeolite	0	0	0	0	100.0	0	1.05	1.32	70.7	81.3
Sand	0	0	0	0.04	99.1	0	1.53	1.80	58.9	73.4
Check	4.29	0.02	0.03	0.25	0	2.31	1.35	4.44	0	0
	WATER DEPTH : 5cm									
Bentonite A	0	0	0	0.01	99.8	0.15	1.44	0	81.0	87.4
Bentonite B	0	0	0	0	100.0	0.39	0.69	0.03	86.7	91.3
Chitosan	0	0	0	0.01	99.8	0	0.81	0.24	87.5	91.7
Coal slag	0	0	0	0.01	99.8	0	2.16	1.20	59.9	73.6
Elvan	0	0	0	0.09	97.9	0	3.09	1.17	49.1	65.9
Zeolite	0	0	0	0.01	99.8	0	2.43	0	71.0	80.9
Sand	0	0	0	0.04	99.1	0.36	2.46	4.11	17.2	45.3
Check	3.99	0.17	0.07	0.14	0	1.23	3.33	3.81	0	0

Abb) Name of weeds : refer to Table 4. 1/ : Efficacy(%) on annuals sub-total, 2/ : Efficacy(%) on pernials sub-total, and 3/ : Efficacy(%) on total weed species to the check(0%), respectively.

dient. Table 5 shows the variations of fresh weights of each weed at 50 days after transplanting. The variations in fresh weight among formulations, water depths and weed species were similar to those in visual ratings.

In other words, *Monochoria vaginalis* and *Cyperus difformis* were controlled completely regardless of formulations and water depths, but barnyardgrass and bulrush were not controlled in shallow water depths. However, they could be readily controlled in water depths greater than 3cm. Among formulation, Bentonite A, Bentonite B, Chitosan gave relatively high control for annual weeds, but injury and control value were low by coal slag and sand-coated oxyfluorfen. In water depths of 3cm or greater, control of annual weeds was excellent regardless of formulations. This result was similar for perennial weeds although the control value was relatively low. Therefore, it was thought that it was better to select formulations showing slight injury rather than show-

ing good efficacy.

Because oxyfuorfen activity was dependent on contact areas of oxyfluorfen to rice plants, crop injury was greater for hybrid cultivar than for Japonica cultivar, was increased with increased water depths, and was increased with younger seedlings. Also, control of weeds was increased with rapid emergence and with small weed species, so that weed species requiring low oxygen for germination grew better in shallow water and less in deep water, with the interaction between water depths and weed growth, The difference in activity of different formulations was probably due to difference in the rate of releasing active ingredients by differential surface structures(See Plate 1 in the previous report(3)). From this standpoint, the formulatons that gave high injury will show high control of weeds, and those with slight injury will show low control of weeds. In this study, oxyfluorfen formulations of Elvan, Coal slag and Bentonite A showed similar results to the above principle, but Bentonite B, Chitosan and Zeolote did not show consistant results in terms of crop injury and control efficacy.

This subtle problem must be resolved by precise study of releasing rate. Looking at the purpose of this study, it is desirable to select oxyfluorfen formulations that show complete control of annual weed and slight injury. Thus, it could be achieved by increasing the first releasing rate of Chitosan to enhance control efficacy or by decreasing the first releasing rate of Bentonite A to reduce crop injury. Further study was required to find out the appropriate rate of application or application methods.

摘 要

筆者들의 前報[3]에서와 同一한 Oxyfluorfen 6劑型을 同一한 硝子室에서 4수준의 관개수심 조건을 부여하여 서로 다른 묘령의 벼와 8종의 주요 논잡초종에 대한 약해 반응 및 약효 차이를 비교 검토하였다. 공시 제형 가운데 Elvan, Coal slag, Chitosan 및 Bentonite B 제형은 비담수 및 천수조건에서, 그리고 Elvan, Coal slag는 심수조건에서 약해가 경미하였고, 제초효과는 Bentonite A 및 B, Chitosan이 전반적으로 높았고, Elvan, Coal slag는 Sand coating과 함께 낮은 경향이었다. 그러나, Oxyfluorfen의 제초대상을 일년생으로 제한하여 판단할 경우에는 제초효과면에서 제형간 차이가 크지 않았으므로 상대적으로 약해가 경미하였던 Elvan, Coal slag, Chitosan 및 Bentonite B제형을 보완 개발하거나 약해 약효간의 유사관계가 분명하였던 Elvan 및 Bentonite A형의 최초 방출 속도를 보완개발함이 기대된다.

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