Controlled Release of Oxyfluorfen from the Variously Complexed Formulations.

V. Effect of Water Leakage on Injury and Efficacy of Selected Formulations

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數種의 結合劑型으로부터 Oxyfluorfen의 放出制御硏究

V. 減水深에 따른 選拔劑型 Oxyfluorfen의 藥害 · 藥效評價

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ABSTRACT

Various formulations of oxyfluorfen were tested to evaluate effect of weed control efficacy and rice injury as affected by different degrees of water leakages. Rice injury was increased with increased water leakages. The formulations of Elvan, Coal slag and Chitosan gave slight injury to rice under all conditions included in terms of visual ratings, plant height and fresh weight production. However, weed control of most formulations was decreased and increased with increased water leakages for annual weeds and perennial weeds, respectively. Annual weeds were controlled greater than 90% by all treatments, but perennial weed control was relatively low. *Scirpus juncoides* was the most tolerant annual weed to Oxyfluorfen. Elvan formulation showed somewhat decreased control of barnyardgrass with increased water leakages. The promising formulations of Oxyfluorfen were Chitosan, Coal slag, Bentonite B and Elvan (if the first releasing rate increased), which injured rice slightly and controlled annual weeds excellently regardless of degrees of water leakages.

INTRODUCTION

Most of herbicides used in rice fields have low solubility or insoluble, and granular formulated for preemergence treatment(4), so that they do not affect transplanted rice but shows high activity on germinating weeds. Thus, they control weeds selectively by forming the treated layer on soil surface in water(1), but their efficacy and injury can be increased or decreased by soil textures(13). Soil C.E.C.(10), flooding depths(17, 6), water pH(9), water temperatures(3), seedling age of rice(14) or planting depths(2). Therefore, it is necessary to examine the variation of efficacy and crop injury as affected by the degree of water leakage relative to soil textures in herbicide-treated rice fields. Especially, it is possible not to suceed in herbicide use in Korea rice fields(11), Where herbicide adsorption is low(8) due to low C.E.C.(10) and organic matter content of soil, and where soil has high pH(9) and is antiquated (15). Activity of contact type herbicides such as diphenylethers and oxadiazon is closely related to contact areas between rice plants and water, so that effect of water depths after treatment is important (12). Also, the cause of injury induction can be due to difference in soil textures or degree of water leakage because of difficulty in absorbing by roots (13, 15, 16). The authors reported that control efficacy and rice injury of various oxyfluorfen formulations can vary depending upon water depths(7). Therefore, the objective of this research was to find

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out promising formulations of oxyfluorfen by examining the characteristics of efficacy and injury when they were affected by different degrees of water leakage.

MATERIALS AND METHODS

Experiment was conducted to evaluate the variations in phytotoxicity and weed control efficacy of controlled-release oxyfluorfen as affected by levels of water leakge. Experiment was carried out using wagner pots in a greenhouse with temperatures set at 26±3 and 18±1 for day and night, respectively, with 10h of illumination. Each pot had a draining hole in the bottom. Water was daily leaked form the pots after treatment. The degree of leakage water was 0, 2 and 4cm daily, and Water was kept 3cm deep right after artificial leakage.

Controlled-release formulations of oxyfluorfen tested were Bentonite A, Bentonite B, Chitosan, Coal slag, Elvan and Zeolite. Also, sand-coated oxyfluorfen 1G was included. Each treatment contained 40g ai/Ha of oxyfluorfen (doubled rate) with three replicates. A Japonica rice cultivar 'Jangsung' was directed-seeded and transplanted with 8-22 and 32days old seedlings, And a hybrid cultivar 'samgang' was direct-seeded and transplanted with 8 days old seedlings. For weed control efficacy, 4 annual weeds including *Echinochloa crus-galli*, *Monochoria vaginalis*, *Cyperus difformis* and *Scirpus juncoides*, and 4 perennial weeds including *Eleocharis kuroguwai*, *Sagittaria pymaea*, *Cyperus serotinus* and *Potamogeton distinctus* were planted as seed and propagules for annual and perennial weeds, respectively. General practices, and evaluation of control efficacy and rice injury were done similar to those of the previous report (7).

RESULTS AND DISCUSSION

1. PHYTOTOXICITY.

Table 1 shows visual ratings of rice injury at 7,

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

Formulkations	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
DAILY DRAINAGE : 0cm																
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
El-van	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
DAILY DRAINAGE : 2cm																
Bentonite A	1(1)	2(3)	1	1	8(8)	3(4)	1	1	9(9)	3(4)	2	1	9(9)	2(3)	1	1
Bentonite B	1(1)	2(4)	1	1	9(9)	3(4)	1	1	9(9)	2(3)	1	1	9(9)	2(2)	0	0
Chitosan	1(1)	2(2)	1	1	9(9)	1(3)	1	1	9(9)	1(2)	1	1	9(9)	2(3)	0	0
Coal slag	1(1)	1(1)	1	1	8(9)	1(1)	1	0	9(9)	1(1)	1	0	9(9)	1(2)	1	0
Elvan	1(1)	1(1)	1	1	8(9)	1(0)	0	0	9(9)	0(1)	1	0	9(9)	0(1)	0	0
Zeolite	1(1)	1(2)	1	1	8(9)	1(2)	1	1	9(9)	2(3)	1	1	9(9)	1(3)	1	0
Sand	1(1)	1(1)	1	1	8(9)	1(1)	1	1	9(9)	1(2)	1	1	9(9)	1(2)	1	1
DAILY DRAINAGE : 4cm																
Bentonite A	1(1)	2(3)	2	1	8(8)	4(4)	2	1	9(9)	3(3)	2	1	9(9)	2(3)	1	0
Bentonite B	1(1)	1(2)	1	0	9(9)	2(3)	1	0	9(9)	1(1)	1	0	9(9)	1(1)	0	0
Chitosan	1(1)	1(2)	1	0	9(9)	1(1)	0	0	9(9)	1(1)	0	0	9(9)	1(1)	0	0
Coal slag	1(1)	1(2)	0	0	9(9)	0(2)	0	0	9(9)	1(2)	0	0	9(9)	1(1)	0	0
Elvan	1(1)	0(1)	0	0	8(9)	0(1)	0	0	9(9)	0(1)	0	0	9(9)	0(0)	0	0
Zeolite	1(1)	1(2)	1	0	9(9)	1(2)	1	0	9(9)	1(1)	0	0	9(9)	2(3)	0	0
Sand	1(1)	0(2)	0	0	9(9)	1(3)	0	0	9(9)	1(1)	1	0	9(9)	1(2)	0	0

Abb.) 1/ : Day assessed (days after transplanting), 2/ : Seeds, 3/, 4/, 5/ : Seedling ages in days after seeding, respectively, and number in parethesis indicates the data fro Hybrid rice variety.

14, 28 and 40 days after transplanting when 7 formulations of oxyfluorfen were applied to rice seedlings with various ages. Regardless of formulations used, rice plants transplanted with 8-day old seedlings died most in 14 days after transplanting. On the other hand, 25 and 35 years old seedlings were bleached with time, Eight-day old seedlings with short plant height and weak stems were sensitive to oxyfluorfen short after transplanting, and were slowly recovered with time although they had endosperms with seedlings.

Injury of most formulations was decreased as water leakage increase. Among formulations tested, Bentonite A, Bentonite B, Zeolite, Chitosan and sand-coated oxyfluorfen gave relatively high injury to rice, but Elvan and Coal slag injured rice slightly, suggesting that formulations of Elvan and Coal slag released slowly right after treatment. This was similar to that in the previous report (7). Especially, that all formulations showed decreased injury with increased water leakage would be due to leakage of released herbicide with water into low layer of soil or due to formation of treated layer stably on soil surface.

Because oxyfluorfen is rapidly absorbed to soil and does not translocate even after absorption by roots, it is not activated without light (5). This similar result could be seen in the plant height of rice at 40 and 50 days after transplanting (Table 2.) Generally, plant height of rice was good under well-drained conditions. Direct-seeded rice all died and 8 day old seedlings showed great variations among formulations and cultivars. Hybrid cultivar with short plant height was injured more than Japonica, and growth of rice was injured more tran Japonica cultivar, and growth of rice was reduced more when 2cm water was leaked than when 0 or 4cm water was leaked. Among formulations, plant height was de-

Table 2. Variation in plant height of rice as affected by various oxyfluorfen formulations under different drainge levels.

Formulations	S[1]		8[2]		25[3]		34[4]	
	40[5]	50[5]	40	50	40	50	40	50
DAILY DRAINAGE : 0cm								
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	34	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
DAILY DRAINGAGE : 2cm								
Bentonite A	0(0)	0(0)	32(13)	41(13)	34	40	33	38
Bentonite B	0(0)	0(0)	31(12)	42(22)	33	46	35	47
Chitosan	0(0)	0(0)	32(12)	40(19)	31	41	39	43
Coal Slag	0(0)	0(0)	35(14)	46(23)	30	44	34	45
Elvan	0(0)	0(0)	35(15)	47(23)	31	43	32	44
Zeolite	.0(0)	0(0)	25(13)	38(22)	28	36	29	42
Sand	0(0)	0(0)	31(44)	44(21)	30	39	30	40
Check	21(7)	31(12)	36(11)	43(17)	31	41	30	41
DAILY DRAINAGE : 4cm								
Bentonite A	0(0)	0(0)	16(9)	30(10)	30	31	28	36
Bentonite B	0(0)	0(0)	19(10)	32(16)	32	40	37	40
Chitosan	0(0)	0(0)	20(10)	34(19)	37	40	39	38
Coal slag	0(0)	0(0)	26(10)	39(26)	35	42	35	43
Elvan	0(0)	0(0)	29(11)	38(21)	32	46	34	44
Zeolite	0(0)	0(0)	23(9)	38(10)	30	40	34	44
Sand	0(0)	0(0)	27(10)	34(16)	31	40	34	42
Check	25(9)	32(12)	30(14)	40(20)	34	43	34	40

Abb.) : Refer to Table 1.

Table 3. Varation in fresh weight of shoots at 50 DAT as affected by various oxyfluorffen formulations under different drainage levels. (unit : g/plant)

Formulations	S	8	25	35
DAILY DRAINAGE : 0cm				
Bentonite A	0(0)	0.46(0.45)	0.73	0.78
Bentonite B	0(0)	0.50(0.45)	0.63	0.78
Chitosan	0(0)	0.60(0.60)	0.63	0.78
Coal slag	0(0)	0.75(0.64)	0.68	0.79
Elvan	0(0)	0.71(0.77)	0.78	0.79
Zeolite	0(0)	0.68(0.56)	0.70	0.73
Sand	0(0)	0.67(0.46)	0.64	0.79
Check	0.71(0.43)	0.61(0.48)	0.73	0.76
DAILY DRAINAGE : 2cm				
Bentonite A	0(0)	0.81(0.40)	0.88	1.20
Bentonite B	0(0)	0.91(0.45)	1.08	1.44
Chitosan	0(0)	0.83(0.65)	1.08	1.30
Coal slag	0(0)	0.90(0.55)	1.05	1.35
Elvan	0(0)	1.38(0.77)	1.25	1.38
Zeolite	0(0)	0.61(0.64)	0.78	1.06
Sand	0(0)	0.52(0.59)	1.03	1.27
Check	0.36(0.1)	0.80(0.80)	0.95	1.25
DAILY DRAINAGE : 4cm				
Bentonite A	0(0)	0.35(0.28)	0.43	0.65
Bentonite B	0(0)	0.80(0.30)	0.75	0.96
Chitosan	0(0)	0.79(0.38)	0.81	1.10
Coal slag	0(0)	0.79(0.58)	0.93	1.07
Elvan	0(0)	0.78(0.54)	0.97	1.08
Zeolite	0(0)	0.73(0.25)	0.83	0.85
Sand	0(0)	0.78(0.36)	0.60	1.00
Check	0.37(0.2)	0.87(0.24)	0.99	1.20

creased with treatments of Bentonite A, Bentonite B, Zeolite and sand-coated formulation. Similar result was obtaied with seedlings of 25 and 35 days old, but differences in rice injury among water leakages or formulations were smaller in 25 and 35days old seedlings than in 8 days seedlings. The formulations of Elvan, Chitosan and Coal slag gave slight injury due probably to small amount of herbicide released right after treatment or to slow release with time consistantly. Similar result was obtained in fresh weight of rice at 50 days after transplanting (Table 3.) Although the responses of rice seedlings with various ages to oxyfluorfen formulations were erratic, fresh weight of rice was high with the treatments of Elvan, Chitosan, Coal Slag and Bentonite B, but rice treated with Bentonite A and Zeolite formulations produced less fresh weight than that with sand-coated formulation.

2. CONTROL EFFICACY

Weed control efficacy did not vary by degrees of water leakages, but control of annual weeds was decreased with increased water leakages. Weed control of perennial weeds was proportional to degrees of water leakages. Perennial weed control efficacy of various oxyfluorfen formulation at 50 days after transplanting is shown in Table 4. *Barnyardgrass*, *Monochoria vaginalis* and *Cyperus difformis* were controlled completely regardless of water leakages or formulations. Control of *Scirpus juncoides* varied among water leakages or formulations from 40 days after transplanting. In particular, control of Scirpus juncoides was decreased with treatment of Bentonite or Elvan, and was decreased with water leakage rather than no leakage.

However, control of perennial weeds was improved as degrees of water leakage increased, and *Sagittaria pygmaea* was controlled better than pondweed or *Cyperus serotinus*. The differential responses among perennial species to oxyfluorfen were probably due to differences in time of emergence and depth of emergence rather than due to characteristics of oxyfluorfen. Among formulations control of perennial weeds varied greatly because the formulations with rapid release and great amount of release gave better control with rice injury, but because the formulations with slow release and small amount of release gave low control value with high safety to rice. Differences in emergence time and growth pattern of perennial weeds brought the great variations in control values.

Table 5 shows fresh weights of each weed at 50 days after transplanting. Regardless of formulations or water leakages, annual weeds were controlled greater than 99%. Elvan formulation that showed least injury to rice gave slightly decreased control (92%) of barnyardgrass with increased water leakage. As reported in the results (6, 7), Elvan formulation was released slowly and consistently right after treatment, but the efficacy was decreased with increased water leakage, so that the first releasing rate of Elvan formulation needed to be increased a little. The variations in fresh weights of perennials were similar to the above result. Therefore, if Elvan formulation is complemented, the formulations of

Table 4. Change in visual rates(0-9 ; Check=0) on weeding efficacy as affected by various oxyfluorfen formulations under diffedrenrt drainage 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
Drainaging into 0cm per day																												
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	6	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	9	9	2	4	7	4	9	3	8	8
Coal slag	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	2	6	1	9	8	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	3	2	8	8
Zeolite	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	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	0	8	7
Drainaging into 2cm per day																												
Bentonite A	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	1	6	2	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	9	5	1	4	0	5	9	5	5
Chitosan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	8	9	9	5	5	5
Coal slag	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	1	7	3	3	1	0	5
Elvan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	5	1	6	5	8	3	2	5
Zeolite	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	5	8	8	9	8	9	9
Sand	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	3	1	7	7	0	0	0	5
Drainaging into 4cm per day																												
Bentonite A	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	6	1	2	5	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	9	4	1	6	6	9	9	8	6
Chitosan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	6	2	7	7	9	9	8	8
Coal slag	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	6	7	8	9	9	3	5	5
Elvan	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	1	7	9	7	2	8	7
Zeolite	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	3	7	9	9	2	6	6
Sand	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	4	2	7	6	8	1	7	7

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)*.

Elvan, Coal slag, Chitosan and Bentoite B could be applicable in rice as controlled release formulations of oxyfluorfen even under different degrees of water leakages.

摘　要

筆者들의 前報(7)에서와 同一한 Oxyfluorfen 6 劑型을 同一한 硝子室에서 3수준의 감수심 조건을 부여하여 서로 다른 묘령의 벼와 8종의 논잡초종에 대한 약해 반응과 약효 차이를 비교 검토하였다. 감수심이 커질수록 대부분 제형의 약해는 증대되는 경향이 있었으며, 특히 Elvan, Coal-slag 및 oxyfluorfen은 감수심의 차이 뿐만 아니라 전체 조건하에서 약해가 경미하였다. 이 제형 경향은 달관 조사나 벼의 초장 및 생체중 변이를 통하여 공통적으로 관찰되었다. 그러나 제초효과에 있어서는 대부분 제형들이 감수심이 커질수록 일년생 잡초종의 방제효과는 저하하고 다년생초종의 방제효과는 증대되는 경향을 보였으며, 일년생초종의 방제력은 90%이상의 높은 수준을 보였으나, 다년생초종의 방제력은 상대적으로 낮은 수준이었다. 특히 올챙고랭이는 일년생초종 가운데 저항성이 가장 컸으며, 제형간에도 Elvan제형이 배수조건하에서 피에 대한 제초력의 저하를 초래하였다. 제형간에도 Elvan제형의 초기용출속도를 다소 증대되도록 제형적 보완이 뒤 따른다면 Elvan을 위시한 Chitosan, Coal-slag 및 Bentonite-B형의 제형들은 감수심이 서로 다른 조건의 논에서도 벼에 대한 약해가 경미하면서 일년생잡초종의 방제력을 높게 기대할 수 있는 방출제어형 oxyfluorfen의 새로운 제형으로 개발 가능성이 있는 것으로 판단된다.

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

Formulations	Annuals					Perennials				Total
	EC	MV	CD	SJ	%1/	SP	PD	CS	%2/	Efficacy(%)
					DAILY DRAINAGE : 0cm					
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	87.8
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
					DAILY DRAINAGE : 2cm					
Bentonite A	0	0	0	0.05	99.6	0.60	2.40	0.42	73.5	86.6
Bentonite B	0	0	0	0.03	99.8	0	2.52	2.58	60.4	80.2
Chitosan	0	0	0	0.02	99.9	0	0.12	2.55	79.3	89.6
Coal slag	0	0	0	0.01	99.9	0	4.80	3.36	36.7	68.5
Elvan	0.05	0	0	0.04	99.3	2.07	2.76	2.97	39.4	69.8
Zeolite	0	0	0	0	100.0	0.03	0.08	0	99.3	99.7
Sand	0	0	0	0.05	99.6	0	0.90	3.66	64.6	82.2
Check	12.86	0.03	0.06	0.10	0	2.05	7.80	3.03	0	0
					DAILY DRAINAGE : 4cm					
Bentonite A	0	0	0	0.01	99.9	0	2.10	0.12	83.7	90.2
Bentonite B	0	0	0	0.06	99.3	0	1.14	1.17	83.0	89.8
Chitosan	0	0	0	0.02	99.8	0	1.35	0.60	85.7	91.3
Coal slag	0.02	0	0	0.04	99.3	0.24	0.06	1.41	87.4	92.2
Elvan	0.72	0	0	0.032	99.8	0	0.99	3.21	69.1	78.2
Zeolite	0	0	0	0.01	99.9	0	0.87	1.53	82.4	89.4
Sand	0.02	0	0	0.02	99.6	0	0.57	2.16	79.2	87.4
Check	9.01	0.01	0.02	0.09	0	1.43	3.84	8.34	0	0

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

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