Effect of Mixing 2, 4-D with Other Herbicides on Growth of Different Rice (*Oryza sativa* L.) Cultivars

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2, 4-D와 除草劑 混合處理가 水稻의 生育에 미치는 影響

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ABSTRACT

The response of rice (*Oryza sativa* L.) cultivars to mixtures of 2, 4-D(2, 4-dichlorophenoxyacetic acid) and other herbicides was investigated to determine if there was an interaction between them. When 2, 4-D was applied, shoot growth of Taipei 309 was more affected than that of IR28 at all concentrations used. In contrast, when thiobencarb (*S*-[(4-chlorophenyl) methyl]diethylcarbamothioate), butachlor [*N*-(buthoxymethyl) -2-chloro-*N*-(2, 6-diethylphenyl) acetamide], and glyphosate [*N*-(phosphonomethyl) glycine] were applied, the shoot growth of Taipei 309 was less affected than that of IR28 at all herbicide concentrations. Combination of 2, 4-D and the lowest thiobencarb concentration was antagonistic for shoot length for both cultivars, but at higher concentrations, it was synergistic. Synergism for shoot fresh weight between 2, 4-D and thiobencarb was observed with IR28 at all concentrations but, for Taipei 309, synergism was observed only at lower 2, 4-D concentrations. Mixing 2, 4-D with butachlor resulted in greater inhibition in shoot length and fresh weight of IR28 than Taipei 309 at all concentrations indicating a synergistic interaction. With combinations of 2, 4-D and glyphosate, an antagonistic interaction for shoot length was observed for both cultivars. A synergistic interaction for shoot fresh weight was observed with IR28 when combinations of the highest concentration of glyphosate and 2, 4-D were applied but there was an antagonistic interaction with Taipei 309.

Key words : Interaction, antagonism, synergism, herbicide.

INTRODUCTION

Combinations of two or more herbicides are frequently used to broaden the spectrum of weed species controlled, reduce costs, reduce herbicide residues in the environment, and extend the period of weed control. However, herbicide combinations may also produce undesirable antagonistic interactions (7, 13, 14, 15).

Beste and Schreiber (1) reported an antagonistic interaction between 2, 4-D and EPTC (*S*-ethyl dipropylthiocarbamate) with sorghum (*Sorghum vulgare* Pers.) and corn (*Zea mays* L.) which was attributed to enhancement of the transformation of EPTC to a nontoxic metabolite by 2, 4-D and the opposite effects between 2, 4-D which is promotive and EPTC which is inhibitive of RNA synthesis. Prendeville et al. (8) reported that a combination of 2, 4-D and EPTC might be synergistic on corn due to their different sites of uptake. An antagonistic interaction on sorghum and giant foxtail (*Setaria faberii* Herrm.) was observed when 2, 4-D was mixed with EPTC, suggesting that growth regulator type herbicides antagonized the inhibition of grass species by carbamate, thiocarbamate, and dithiocarbamate her-

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bicides (9).

Generally, antagonism between herbicides has been attributed to a combination of chemical incompatibility, physiological interference within the plant, reduced herbicide absorption, and decreased conversion to the toxic metabolite (10, 11, 12).

So many components including 2, 4-D and other phytohormones are incorporated into the culture medium, that an interaction may have occurred when other herbicides were added into the medium. In studies of herbicide tolerance through tissue culture, mixtures of 2, 4-D and other herbicides will be incorporated into the medium because 2, 4-D is used as a growth regulator instead of auxin for callus induction or maintenance of callus growth. Thus, a knowledge of the interaction of 2, 4-D and other herbicides which will be incorporated into the medium for cell culture is important in order to determine the effect of herbicides on cell or callus growth on the medium. In addition, the lack of specific target sites for phytotoxic action in highly undifferentiated callus may be the reason for differential responses to herbicides between callus and whole plants. This means that different responses to herbicides between calli and seedlings can be obtained and, therefore, studies are required on the interaction between 2, 4-D and other herbicides which are incorporated into the same medium.

This experiment was conducted to determine if there was an interaction between 2, 4-D and other herbicides on rice cultivar growth and to compare cultivar responses.

MATERIALS AND METHODS

Ten seeds of Taipei 309 and IR28 which had been sterilized for 15 min. with 0.1% mercuric chloride solution and thoroughly washed three times with sterilized water, were germinated on filter paper in 10 cm petri dishes. The herbicides used in this experiment were 2, 4-D at 0.5, 1.0, 2.0, 4.0 mg/1 and butachlor, thiobencarb, glyphosate at 10^{-6}, 10^{-5}, 10^{-4}, 10^{-3} M. 2, 4-D at all concetrations was mixed with all the concentrations of butachlor, thiobencarb, and glyphosate. Ten ml of each herbicide concentration or each mixture were added to the petri dishes which were then placed in a dark incubation room for 5 days at a constant temperature of 30±1℃. Thereafter, the petri dishes were kept in a lighted incubation room for 2 days at a constant temperature of 30±1℃ in order to develop primary leaves from the coleoptile. Treatments were replicated three times. Data on shoot length and shoot fresh weight were taken 7 days after treatment.

Callus was induced in the dark at 25±1℃ from scutellar tissues of rice on modified Murashige Skoog (MS) (6) medium supplemented with 2.0 mg/1 of 2, 4-D and 0.2 mg/1 of BAP (benzylamino purine). Eight-week old calli were transferred to media containing 10^{-5} M butachlor and thiobencarb. The increase in callus fresh weight was determined 30 days after treatment.

The method of Colby (3) was used to calculate the expected response(E) using the equation :

$$E = \frac{(Xr)\ (Yp)}{100}$$

where Xr = % of control of herbicide X at concentration r, Yp = % of control of herbicide Y at concentration p. When the observed response(O) is less than the expected response(E) the interaction is synergistic. When O is higher than E, the effect is antagonistic. An additive effect is indicated when O is approximately equal to E.

RESULTS AND DISCUSSION

Similar trends in the response of the cultivars to butachlor were observed for both seedlings and calli. However, IR28 which was susceptible to thiobencarb with respect to shoot length showed tolerance to the herbicide with respect to callus growth (Table 1). Zilkah et al. (16) reported that there was fairly good correlation in phytotoxicity between seedling growth and callus growth except for some photosynthetic inhibitors.

2, 4-D at all affected shoot growth, The degree of inhibition increased as the herbicide concentration increased for both Taipei 309 and IR28 ; Taipei 309 being more affected than IR28 at all concentrations

Table 1. Effect of 10^{-5} M butachlor and thiobencarb on shoot and callus growth of several rice cultivars.

Cultivar	Butachlor		Thiobencarb	
	Shoot length	Increase in callus fresh weight	Shoot length	Increase in callus fresh weight
IR31917-45-3-2-2	44.2	44.6	-	-
Taipei 309	62.1	97.7	69.0	71.2
IR28	-	-	45.5	106.4
IR9660-50-3-1	-	-	76.8	86.3

(Tables 2, 3, and 4).

At lower 2, 4-D concentrations (0.5 and 1.0 mg/1), shoot fresh weight increased for both Taipei 309 and IR28 ; the percentage increase being higher with Taipei 309. But, at higher concentrations, inhibition in fresh weight of Taipei 309 was higher than that of IR28 (Tables 5, 6, and 7). In general, auxinic levels of 2, 4-D enhance RNA and protein synthesis and cell division resulting in increase in fresh weight whereas herbicidal concentrations inhibit these processes (2, 4).

In contrast, when thiobencarb, butachlor, and glyphosate were applied, the shoot length of Taipei 309 was less affected than that of IR28 at all herbicide concentrations (Tables 2, 3, and 4). A similar trend was observed for shoot fresh weight (Tables 5, 6, and 7).

IR28 was more affected by thiobencarb, butachlor, and glyphosate than Taipei 309 in terms of shoot length and fresh weight but when 2, 4-D was applied, IR28 was less affected than Taipei 309. This indicates that there are differences in physiological and biochemical processes such as RNA and protein synthesis which are the major mode of action of these herbicides and suggests that when mixtures of 2, 4-D and the other herbicides are applied different interactions will occur.

Differential response of rice cultivars to herbicides

Table 2. Interaction between 2, 4-D and thiobencarb on shoot length of different rice cultivars.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	(mg/1)						
2, 4-D	0.5	75.8	80.3				
2, 4-D	1.0	66.7	85.2				
2, 4-D	2.0	45.5	60.7				
2, 4-D	4.0	27.3	39.3				
	(M)						
Thiobencarb	10^{-6}	97.0	77.0				
Thiobencarb	10^{-5}	72.7	27.9				
Thiobencarb	10^{-4}	15.2	8.2				
2, 4-D (mg/1) + Thiobencarb (M)							
	$0.5+10^{-6}$	97.0	86.9	73.5	61.8	−23.5	−25.1
	$0.5+10^{-5}$	51.5	27.9	55.1	22.4	+ 3.6	− 5.5
	$0.5+10^{-4}$	0.0	0.0	11.5	6.6	+11.5	+ 6.6
	$1.0+10^{-6}$	69.7	70.5	64.7	65.6	− 5.0	− 4.9
	$1.0+10^{-5}$	39.4	24.6	48.5	23.8	+ 9.1	− 0.8
	$1.0+10^{-4}$	0.0	6.6	10.1	7.0	+10.1	+ 0.4
	$2.0+10^{-6}$	60.6	65.6	44.1	46.7	−16.5	−18.9
	$2.0+10^{-5}$	39.4	27.9	33.1	16.9	− 6.3	−11.0
	$2.0+10^{-4}$	0.0	0.0	6.9	5.0	+ 6.9	+ 5.0
	$4.0+10^{-6}$	33.3	32.8	26.5	30.3	− 6.8	− 2.5
	$4.0+10^{-5}$	33.3	24.6	19.8	11.0	−13.5	−13.6
	$4.0+10^{-4}$	0.0	0.0	4.1	3.2	+ 4.1	+ 3.2

[1] + = synergistic, − = antagonistic.

Table 3. Interaction between 2, 4-D and butachlor on shoot length of different rice cultivars.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1)]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	(mg/1)						
2, 4-D	0.5	75.8	80.3				
2, 4-D	1.0	66.7	85.2				
2, 4-D	2.0	45.5	60.7				
2, 4-D	4.0	27.3	39.3				
	(M)						
Butachlor	10^{-6}	93.9	85.2				
Butachlor	10^{-5}	69.7	50.8				
Butachlor	10^{-4}	7.0	3.3				
2, 4-D (mg/1) + Butachlor (M)							
	$0.5+10^{-6}$	87.9	44.3	71.2	68.4	−16.7	+24.1
	$0.5+10^{-5}$	48.5	26.2	52.8	40.8	+ 4.3	+14.6
	$0.5+10^{-4}$	0.0	0.0	2.3	2.6	+ 2.3	+ 2.6
	$1.0+10^{-6}$	60.6	49.2	62.6	72.6	+ 2.0	+23.4
	$1.0+10^{-5}$	45.5	13.1	46.5	43.3	+ 1.0	+30.2
	$1.0-10^{-4}$	0.0	0.0	2.0	2.8	+ 2.0	+ 2.8
	$2.0+10^{-6}$	42.4	32.8	42.7	51.7	+ 0.3	+18.9
	$2.0+10^{-5}$	42.4	9.8	31.7	30.8	−10.7	+21.0
	$2.0+10^{-4}$	0.0	0.0	1.4	2.0	+ 1.4	+ 2.0
	$4.0+10^{-6}$	33.3	23.0	25.6	33.5	− 7.7	+10.5
	$4.0-10^{-5}$	33.3	9.8	19.0	20.0	−14.3	+10.2
	$4.0+10^{-4}$	0.0	0.0	0.8	1.3	+ 0.8	+ 1.3

1) + = synergistic ; − = antagonistic

Table 4. Interaction between 2, 4-D and glyphosate on shoot length of different rice cultivars.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1)]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	(mg/1)						
2, 4-D	0.5	75.8	80.3				
2, 4-D	1.0	66.7	85.2				
2, 4-D	2.0	45.5	60.7				
2, 4-D	4.0	27.3	39.3				
	(M)						
Glyphosate	10^{-6}	90.9	86.9				
Glyphosate	10^{-5}	100.0	80.3				
Glyphosate	10^{-4}	60.6	36.1				
Glyphosate	10^{-3}	21.2	8.2				
2, 4-D (mg/1) + Glyphosate (M)							
	$0.5+10^{-6}$	100.0	93.4	68.9	69.8	−31.1	−23.6
	$0.5+10^{-5}$	90.9	88.5	75.8	64.5	−15.1	−24.0
	$0.5+10^{-4}$	81.8	57.4	45.9	29.0	−35.9	−28.4
	$0.5+10^{-3}$	30.3	13.1	16.1	6.6	−14.2	− 6.5
	$1.0+10^{-6}$	93.9	85.2	60.6	74.0	−33.3	−11.2
	$1.0+10^{-5}$	72.7	86.9	66.7	68.4	− 6.0	−18.5
	$1.0+10^{-4}$	69.7	65.6	40.4	30.8	−29.3	−34.8
	$1.0+10^{-3}$	39.4	11.5	14.1	7.0	−25.3	− 4.5

1) − = antagonistic

Table 4. Continued.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1)]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	$2.0+10^{-6}$	45.5	78.7	41.4	52.7	− 4.1	−26.0
	$2.0+10^{-5}$	60.6	60.7	45.5	48.7	−15.1	−12.0
	$2.0+10^{-4}$	51.5	60.7	27.6	21.9	−23.9	−38.8
	$2.0+10^{-3}$	33.3	9.8	9.6	5.0	−23.7	− 4.8
	$4.0+10^{-6}$	36.4	37.7	24.8	34.2	−11.6	− 3.5
	$4.0+10^{-5}$	33.3	34.4	27.3	31.6	− 6.0	− 2.8
	$4.0+10^{-4}$	30.3	29.5	16.5	14.2	−13.8	−15.3
	$4.0+10^{-3}$	30.3	11.5	5.8	3.2	−24.5	− 8.3

[1)] − =antagonistic.

has been observed in many instances. Moody and Madrid (5) concluded that differential responses to herbicides including butachlor and thiobencarb are caused by differences in morphology, physiology, and biochemistry of the rice cultivar which affect herbicide uptake, translocation, and metabolism.

Cultivar differences in response to 2, 4-D and the other herbicides may create difficulty in applying tissue or cell culture techniques in which a mixture of 2, 4-D and herbicides such as butachlor, thiobencarb, and glyphosate will be incorporated into the medium to screen for cultivar tolerance to herbicides.

The shoot length of Taipei 309 was less affected than that of IR28 when 2, 4-D at all concentrations was mixed with thiobencarb at 10^{-5} M. However, at the other thiobencarb concentrations, little difference was observed between the two cultivars (Table 2).

At the lowest thiobencarb concentration, combination with 2, 4-D was antagonistic for both cultivars but, at higher concentrations, it was synergistic sug-

Table 5. Interaction between 2, 4-D and thiobencarb on shoot fresh weight of different rice cultivars.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1)]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	(mg/1)						
2, 4-D	0.5	138.0	118.6				
2, 4-D	1.0	128.9	102.7				
2, 4-D	2.0	92.6	97.3				
2, 4-D	4.0	63.6	81.9				
	(M)						
Thiobencarb	10^{-6}	89.7	96.5				
Thiobencarb	10^{-5}	79.3	55.3				
Thiobencarb	10^{-4}	17.8	11.5				
2, 4-D (mg/1) + Thiobencarb (M)							
	$0.5+10^{-6}$	88.8	96.5	123.8	114.4	+35.0	+17.9
	$0.5+10^{-5}$	81.0	52.2	109.4	65.6	+28.4	+13.4
	$0.5+10^{-4}$	0.0	0.0	24.6	13.6	+24.6	+13.6
	$1.0+10^{-6}$	89.7	82.3	115.6	99.1	+25.9	+16.8
	$1.0+10^{-5}$	86.4	42.0	102.2	56.8	+15.8	+14.8
	$1.0+10^{-4}$	0.0	7.1	22.9	11.8	+22.9	+ 4.7
	$2.0+10^{-6}$	84.3	81.4	83.1	93.9	− 1.2	+12.5
	$2.0+10^{-5}$	78.5	52.2	73.4	53.8	− 5.1	+ 1.6
	$2.0+10^{-4}$	0.0	0.0	16.5	11.2	+16.5	+11.2
	$4.0+10^{-6}$	78.9	65.9	57.0	79.0	−21.9	+13.1
	$4.0+10^{-5}$	72.7	43.4	50.4	45.3	−22.3	+ 1.9
	$4.0+10^{-4}$	0.0	0.0	11.3	9.4	+11.3	+ 9.4

[1)] + =synergistic, − =antagonistic.

gesting that the interaction was concentration dependent. Generally, the degree of antagonism between the two herbicides was higher with IR28 than with Taipei 309. This indicates that greater inhibition in shoot growth of Taipei 309 will occur when mixtures of 2, 4-D and thiobencarb are applied.

Antagonism between herbicides is attributed to a combination of a chemical incompatibility, a physiological interference within the plant, reduced herbicide absorption, and decreased conversion to the toxic metabolite (10, 11, 12). In this syudy, it is difficult to explain the causes for the antagonistic interaction.

Prendeville et al. (8) observed that 2, 4-D uptake was primarily through the shoot of corn while EPTC was primarily absorbed by the roots suggesting that a combination of the two herbicides might be synergistic due to their different sites of uptake. However, Prendeville et al. (9) reported that an antagonistic interaction was observed when 2, 4-D was mixed with EPTC and applied to sorghum and giant foxtail but there was an additive interaction with dicotyledonous species. They observed that growth regulator type herbicides antagonized carbamate, thiocarbamate, and dithiocarbamate inhibition in grass species. Beste and Schreiber (1) reported that 2, 4-D did not interfere with uptake or subsequent movement of C^{14}-labeled EPTC within the sorghum plant. Rhodes and Coble (12) concluded that the antagonism which was observed for grass control, when a combination of sethoxydim and bentazon was applied, was due to chemical incompatibility rather than a physiological interference within the plant.

Combinations of higher concentrations of 2, 4-D and thiobencarb at 10^{-5} M resulted in less inhibition in shoot fresh weight of Taipei 309 than of IR28 (Table 5). Synergism between the two herbicides was observed with IR28 at all concentrations but, in Taipei 309, synergism was observed only at the lower 2, 4-D concentrations suggesting that shoot fresh weight of Taipei 309 was greatly affected by the mixtures at lower 2, 4-D concentrations.

Table 6. Interaction between 2, 4-D and butachlor on shoot fresh weight of different rice cultivars.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	(mg/1)						
2, 4-D	0.5	138.0	118.6				
2, 4-D	1.0	128.9	102.7				
2, 4-D	2.0	92.6	97.3				
2, 4-D	4.0	63.6	81.9				
	(M)						
Butachlor	10^{-6}	95.9	82.7				
Butachlor	10^{-5}	88.0	55.3				
Butachlor	10^{-4}	3.3	5.8				
2, 4-D (mg/1) + Butachlor (M)							
	$0.5+10^{-6}$	113.2	54.0	132.3	98.1	+19.1	+44.1
	$0.5+10^{-5}$	100.8	25.2	121.4	65.6	+20.6	+40.4
	$0.5+10^{-4}$	0.0	0.0	4.6	6.9	+ 4.6	+ 6.9
	$1.0+10^{-6}$	100.4	61.1	123.6	84.9	+23.2	+23.8
	$1.0+10^{-5}$	97.9	30.5	113.4	56.8	+15.5	+26.3
	$1.0+10^{-4}$	0.0	0.0	4.3	6.0	+ 4.3	+ 6.0
	$2.0+10^{-6}$	83.5	54.4	88.8	80.5	+ 5.3	+26.1
	$2.0+10^{-5}$	79.3	16.8	81.5	53.8	+ 2.2	+37.0
	$2.0+10^{-4}$	0.0	0.0	3.1	5.6	+ 3.1	+ 5.6
	$4.0+10^{-6}$	81.8	56.2	61.0	67.7	−20.8	+11.5
	$4.0+10^{-5}$	77.7	15.0	56.0	45.3	−21.7	+30.3
	$4.0+10^{-4}$	0.0	10.6	2.1	4.8	+ 2.1	− 5.8

[1] + = synergistic, − = antagonistic.

Table 7. Interaction between 2, 4-D and glyphosate on shoot fresh weight of different rice cultivars.

Herbicide	Concentration	% of control (Observed response)		Expected response		Difference[1]	
		Taipei 309	IR28	Taipei 309	IR28	Taipei 309	IR28
	(mg/1)						
2, 4-D	0.5	138.0	118.6				
2, 4-D	1.0	128.9	102.7				
2, 4-D	2.0	92.6	97.3				
2, 4-D	4.0	63.6	81.9				
	(M)						
Glyphosate	10^{-6}	100.0	92.9				
Glyphosate	10^{-5}	112.0	83.6				
Glyphosate	10^{-4}	81.8	57.5				
Glyphosate	10^{-3}	19.0	12.4				
2, 4-D (mg/1) + Thiobencarb (M)							
	$0.5+10^{-6}$	197.1	113.7	138.0	110.2	−59.1	− 3.5
	$0.5+10^{-5}$	175.2	110.2	154.6	99.1	−20.6	−11.1
	$0.5+10^{-4}$	145.9	93.4	112.9	68.2	−33.0	−25.2
	$0.5+10^{-3}$	43.0	8.0	26.2	14.7	−16.8	+ 6.7
	$1.0+10^{-6}$	124.8	97.8	128.9	95.4	+ 4.1	− 2.4
	$1.0+10^{-5}$	113.2	87.6	144.4	85.9	+31.2	− 1.7
	$1.0+10^{-4}$	104.1	83.6	105.4	59.1	+ 1.3	−24.5
	$1.0+10^{-3}$	42.6	8.0	24.5	12.7	−18.1	+ 4.7
	$2.0+10^{-6}$	100.8	91.6	92.6	90.4	− 8.2	− 1.2
	$2.0+10^{-5}$	105.0	83.6	103.7	81.3	− 1.3	− 2.3
	$2.0+10^{-4}$	95.5	89.8	75.7	55.9	−19.8	−33.9
	$2.0+10^{-3}$	29.3	7.5	17.6	12.1	−11.7	+ 4.6
	$4.0+10^{-6}$	86.0	58.8	63.6	76.1	−22.4	+17.3
	$4.0+10^{-5}$	83.5	57.1	71.2	68.5	−12.3	+11.4
	$4.0+10^{-4}$	55.0	45.1	52.0	47.1	− 3.0	+ 2.0
	$4.0+10^{-3}$	26.0	8.8	12.1	10.2	−13.9	+ 1.4

[1] + = synergistic, − = antagonistic.

Mixing 2, 4-D with butachlor resulted in greater inhibition in shoot length and fresh weight of IR28 than Taipei 309 at all concentrations indicating a synergistic interaction (Tables 3 and 6).

With combinations of 2, 4-D and glyphosate, there was little difference in the inhibition of shoot length between Taipei 309 and IR28. At all concentrations, an antagonistic interaction was observed for both cultivars (Table 4).

Mixtures of 2, 4-D and lower concentrations of glyphosate increased the shoot fresh weight of Taipei 309. For all mixtures of the two herbicides, greater inhibition in shoot fresh weight was observed with IR28 than with Taipei 309 (Table 7). A synergistic interaction was observed with IR28 when combinations of the highest concentration of glyphosate and 2, 4-D were applied but there was an antagonistic interaction with Taipei 309.

In this study, cultivar differences in response to 2, 4-D and the other herbicides used were observed. The reaction between 2, 4-D and the other herbicides was concentration dependent, depended on the cultivars and the parameters measured such as shoot length and fresh weight. This may be partially due to auxinic levels of 2, 4-D resulting in increase in fresh weight. Even though direct correlation of the interactions between seedling growth and callus growth for cultivar response to the mixtures of 2, 4-D and thiobencarb may be difficult because callus is a highly undifferentiated state, generally, the degree of antagonism was higher with IR28 than with Taipei 309. This result suggests that an interaction between medium components and herbicide(s) which will be used for screening of herbicide tolerance through tissue culture on seedlings or calli should be determined prior to the screening experiment.

摘 要

2, 4-D와 除草劑의 相互作用을 調査키 위하여 2, 4-D와 除草劑의 混合處理가 水稻의 初期生育에 미치는 影響을 調査한 結果는 다음과 같다.

2, 4-D 處理에 의한 新鞘生育은 品種間에 差異가 있었는데 IR28보다 Taipei 309의 新鞘生育이 더욱 抑制된 반면에 thiobencarb, butachlor 및 glyphosate 處理에 의한 IR28의 新鞘生育 抑制는 Taipei 309 보다 더욱 크게 나타났다.

2, 4-D와 thiobencarb 混合處理時에 相互作用은 thiobencarb 濃度가 낮은 處理區의 新鞘길이에 대하여 두 品種 共히 拮抗作用을 나타내었고 thiobencarb 高濃度에서는 相乘作用을 보였다. 新鞘의 生體重에 대한 2, 4-D와 thiobencarb의 相互作用은 IR28의 경우 모든 處理區에서 相乘作用을 나타낸 반면에 Taipei 309의 경우에는 2, 4-D의 濃度가 낮을 때만 相乘作用이 나타났다.

2, 4-D와 butachlor 混合處理에 의해서는 IR28의 新鞘길이와 生體重이 Taipei 309보다 더욱 높은 抑制現象을 보여 相乘作用을 나타내었다.

2, 4-D와 glyphosate 混合時에는 新鞘의 길이에서는 두 品種 공히 拮抗作用을 보였으나, 2, 4-D와 glyphosate의 最高濃度 混合時에는 新鞘의 生體重에 대해서 IR28은 相乘作用을 보인 반면에 Taipei의 309는 拮抗作用을 나타내었다.

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