RESPONSE OF WEEDS AND RICE TO CERTAIN GRANULAR HERBICIDES [1]

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INTRODUCTION

Since 1964, a total of four weed control experiments have been conducted at the Chiayi Agricultural Experiment Station in cooperation with The International Rice Research Institute (Chang, 1965 ; 1968 ; 1969 ; 1971a). From these experiments useful information has been obtained which has contributed greatly to the understanding of problems related to chemical weed control for transplanted rice in Taiwan. As a result, the acreage of rice field controlled with herbicides has increased rapidly from less than 500 ha in 1966 to more than 15,000 ha in 1970 (Chang, 1971b). This paper summarizes results obtained from the fifth cooperative experiment conducted in the second crop of 1971.

MATERIALS AND METHODS

The experiment was conducted in the second (wet season) crop of 1971 at the Wan—tien—li farm of the Chiayi Agricultural Experiment Station. The predominant soil type of the experimental plots is clay loam. The surface soil has pH value of 5.2 and contains 2.6% organic matter. Chianung 242, a japonica variety, was subjected to 9 herbicide treatments as listed in Table 1. Unweeded and handweeded treatments were also included for comparison. The experiment was laid out in a randomized complete block design with four replications. The plot size was 2×4 m and consisted of 8 rows. The plant spacing was 25×20 cm with approximately 5 seedlings being transplanted at each hill. Fertilizers were applied at the rate of 80,40,and 40 kg per ha for N, P_2O_5, and K_2O, respectively.

Mixed seeds of *Echinochloa crusgalli*, *Monochoria vaginalis*, and *Cyperus difformis* were sown right after transplanting at the rate of 2—3 kg per ha to ensure uniform initial weed densities in all plots. The response of weed and rice to herbicide treatments was rated by an arbitray visual scale of 1 to 5 at 19 days after transplanting and at panicle initiation stage. Scale 1 indicates either excellent weed control or no rice injury and Scale 5, no control of weeds or complete kill of rice plants. Grain yield and several agronomic characters were also recorded. Climatic data during the period from transplanting to 60 days after transplanting are given in Table 2.

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Table 1. Herbicide treatments.

Treatment number	Herbicide treatment	Formulation concentration (%)	Rate of application (kg/ha active ingredient)	Quantity of formulation (kg/ha)	Time of application (DAT)
1	2,4—D IPE (G)	3.2	0.8	25	4
2	CP 53619 (G)	5	1.0	20	4
3	CP 53619/2,4—D BE (G)	3.3/1.67	1.0/0.5	30	4
4	Benthiocarb (G)	10	1.0	10	4
5	Benthiocarb (G) +2,4—D IPE (G)	10+3.2	1.0+0.5	10+15.6	4
6	C—285 (G) +2,4—D IPE (G)	7.5+3.2	0.75+0.5	10+15.6	4
7	C—288 (G) +2,4—D IPE (G)	7.5+3.2	0.75+0.5	10+15.6	4
8	NTN 5006 / 2,4—D IPE (G)	7.0/1.5	2.0/0.45	30	4
9	C—290 (G) +2,4—D IPE (G)	7.5+3.2	0.75/0.5	10+15.6	4
10	Unweeded control	—	—	—	—
11	Handweeded control	—	—	—	—

IPE=Isopropyl ester. BE=Butyl ester. G=granule.
DAT=Days after transplanting.

Table 2. Climatic data during the early growing stages of the second crop, 1971.

Period	Rainfall (mm)	Number of rainy days	Number of sunshine hours	Relative humidity (%)	Temperature °C		
					Maximum	Minimum	Average
July 25—31	121.6	4	10.2	72	32.0	25.5	28.8
Aug. 1—5	257.5	4	19.0	73	32.0	23.4	27.7
6—10	127.7	2	6.0	66	32.2	24.5	28.4
11—15	13.5	4	21.2	69	31.3	25.1	28.2
16—20	1.8	2	23.6	64	32.7	24.6	28.7
21—25	0	0	22.3	61	32.5	25.2	28.9
26—31	0	0	30.6	60	32.5	25.1	28.8
Sept. 1—5	78.8	2	23.1	63	32.8	22.8	27.8
6—10	3.3	1	21.2	65	32.8	24.9	28.9
11—15	78.2	1	15.3	67	32.0	25.3	28.7
16—20	261.0	3	4.7	81	28.3	23.6	26.0
21—25	58.5	2	13.2	76	30.7	24.0	27.4

RESULTS AND DISCUSSION

Response of Weeds to Herbicide Treatments :

As in the previous experiments, the experimental plots were infested predominantly with broadleaf weeds such as *Monochoria vaginalis* followed by *Cyperus difformis*, a sedge weed while population density of grassy weeds such as *Echinochloa crusgalli* was generally low. Weed control ratings made at 19 days after transplanting and at panicle initiation stage are shown in Table 3. The combination of granular C—288 and 2,4—D isopropyl ester (IPE) gave the best control of weeds and that of C—285+2,4—D IPE ranked second. Relatively good initial control of weeds was also obtained with the combination of granular C—290 and 2,4—D IPE and NTN5006/2,4—D IPE, Single application of granular CP53619,2,4—D IPE, and Benthiocarb resulted in the poorest control of weeds but CP53619/2,4—D butyl ester (BE) and Benthiocarb+2,4—D IPE provided considerably better control of weeds, indicating that the inclusion of either 2,4—D BE or 2,4—D IPE greatly enhances the weed control effect of CP53619 and Benthiocarb, also known as Machete and Saturn, respectively. This finding would be of great practical importance to chemical weed control in the second crop of rice when high temperature is available for the growth of weeds.

Table 3. Response of weeds and rice to herbicide treatments at early growing stages.

Treatment	Weed control rating		Rice toxicity rating		Rice growth at 40 DAT	
	19 DAT	PIS	19 DAT	PIS	Plant height (cm)	Tillers per hill
1	2.4	3.4	1.0	1.0	71.0	13.3
2	2.1	3.0	1.0	1.0	73.7	13.8
3	1.4	1.8	1.3	1.0	72.2	14.6
4	2.5	3.4	1.0	1.0	71.7	14.5
5	1.5	2.2	1.0	1.0	73.2	15.1
6	1.2	1.6	1.0	1.0	72.7	16.4
7	1.1	1.2	1.1	1.0	75.4	16.1
8	1.6	2.1	1.0	1.0	74.9	15.7
9	1.5	2.1	1.0	1.0	74.5	14.7
10	5.0	5.0	1.0	1.0	70.7	11.5
11	1.0	1.0	1.0	1.0	73.9	16.4

DAT=Days after transplanting. PIS=Panicle initiation stage.

It should be pointed out that the experimental plots were reprepared for transplanting one week after the initial land preparation because of the shortage of labors. Since weeds already emerged when land was being reprepared, it was possible that few weeds floating on the water surface became reestablished on the plots after the transplanting. This

means that there were already few weeds at 2—3 leaf stage when herbicides were applied 4 days after transplanting. The good weed control of C—288+2,4—D IPE and C—285+2,4—D IPE in this experiment indicated that these chemical combinations possess excellent weed control effect at both pre—and post—emergence stages. On the other hand, the poor weed control recorded for granular CP 53619,2,4—D IPE, and Benthiocarb under the condition of this experiment clearly demonstrated that these herbicides could not inhibit the growth of weeds at late post—emergence stage,even though they may have good control of weeds at pre—emergence stage (Chang,1971a ; Chang and De Datta,1972) . Granular Benthiocarb was applied at the rate of 1.0kg/ha *ai* in this experiment. Apparently,this rate is too low to control weeds effectively at the post—emergence stage.

Response of Rice to Herbicide Treatments.

Rice toxicity rating made at 19 days after transplanting and at panicle initiation stage are also given in Table 3. It was observed that the growth of rice plants was slightly inhibited by the application of CP 53619/2,4—D BE and C—288+2,4—D IPE when rating was made at 19 days after transplanting but rice plants recovered from the chemical injury rather quickly and there was practically no trace of toxicity when rating was made at panicle initiation stage. The growth of rice plants was not affected by the rest of herbicide treatments. Since low temperature tends to enhance the phytotoxicity effect of phenoxy acid herbicides (Chang,1971a), it appears likely that herbicide treatments in combination with either 2,4—D BE or 2,4—D IPE evaluated in this experiment would be more toxic to rice plants when applied in the first (dry season) crop.

Plant height and number of tillers per hill recorded at 40 days after transplanting revealed that the growth of rice plants was not affected directly by the application of herbicides in the early growth stage (Table 3). However, treatments with poor control of weeds such as 2,4—D IPE, CP53619, and Benthiocarb were found to produce shorter rice plants and/or less tillers per hill, indicating that the growth of rice plants may be indirectly affected by severe weed competition.

Days to heading, plant height and number of panicles per hill measured at maturing stage as well as grain yields are presented in Table 4. It can be seen that poor control of weeds in the treatments of 2,4—D IPE,CP 53619, Benthiocarb, and unweeded control generally hastened the heading of rice and reduced the plant height as well as number of panicles per hill,resulting in the reduction of grain yields.The unweeded control gave the lowest yield of 3,238 kg per ha which was 32% lower than 4,742 kg per ha produced by handweeded control. Granular 2,4—D IPE and Benthiocarb gave the second and third lowest yields which were significantly lower than that of handweeded control.The highest yield was produced by handweeded control while granular C−288+2,4−D IPE and C−285 +2,4−D IPE gave the second and third highest yields. Difference in grain yield among these three higher yielding treatments was not significant.The high grain yields of these treatments may be attributable to their good weed control effects.

Table 4. Response of rice to herbicide treatments at late growing stages

Treatment	Days to heading	Plant height (cm)	Panicles per hill	Grain yield (kg/ha)	Index A (%)	Index B (%)
1	55	105.9	11.8	3,794 c*	117	80
2	58	107.0	12.6	4,292 ab	133	91
3	60	110.0	13.4	4,411 ab	136	93
4	56	107.4	12.7	4,016 bc	124	85
5	59	109.7	13.4	4,338 ab	134	92
6	58	110.7	14.5	4,702 a	145	99
7	59	110.0	14.1	4,717 a	146	100
8	57	108.8	12.4	4,413 ab	136	93
9	57	109.9	13.1	4,239 abc	131	89
10	54	100.5	10.1	3,238 d	100	68
11	59	110.6	14.7	4,742 a	147	100

*Grain yields with letters in common are not significantly different from each other at the 5% level.

SUMMARY

The response of weeds and rice to 11 herbicide treatments evaluated at the Chiayi Agricultural Experiment Station, Chiayi, Taiwan in the second crop of 1971 are reported.

Granular C—288+2,4—D IPE and C—285+2,4—D IPE provided the best control of weeds. Good initial control of weeds was also obtained with C—290+2,4—D IPE and NTN5006/2,4—D IPE, Granular 2,4—D IPE, CP53619, and Benthiocarb gave the poorest control of weeds, but weed control effect of CP53619 and Benthiocarb was considerably improved when combined with 2,4—D BE and 2,4—D IPE, respectively.

Rice plants were not injured by the herbicide treatments but the growth of rice plants was indirectly affected by weed competition in the treatments with poor control of weeds. Poor weed control treatments also hastened the heading of rice and reduced the plant height as number of panicles per hill of adult plants. As a result, grain yields of these treatments decreased significantly. The handweeded control gave the highest yield which was followed by C—288+2,4—D IPE, while C—285+2,4—D IPE ranked third in its yield production. Difference in yield among these high yielding treatments failed to attain significance.

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雜草及水稻對若干稻田除草劑之反應

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摘　　要

本文係報告民國60年第2期作嘉義農業試驗分所與國際稻米研究所合作舉辦第5次稻田除草劑試驗所得之結果。

C—288+2,4—D IPE 與 C—285+2,4—D IPE 粒劑之治草效果最佳。C—290+2,4—D IPE 與NTN 5006/2,4—D IPE 粒劑之初期治草效果亦佳。2,4—D IPE，CP53619 與 Benthiocarb 粒劑之治草效果最差，惟後兩種除草劑若分別與 2,4—D BE 及 2,4—D IPE 混合施用時，其治草效果即改觀。

本試驗供試除草劑對水稻均未構成嚴重藥害，惟在除草效果較差之處理，水稻之發育則遭受雜草競爭之間接爲害。水稻在除草較差之處理多提早抽穗，其成熟期、株高及每株穗數亦見減少，而稻谷產量顯著低減。人工除草處理之稻谷產量最高， C—288+2,4—D IPE 粒劑次之，C—285+2,4—D IPE 粒劑居第3，三者間之產量差異不顯著。