THE EFFECT OF WEEDS ON RICE IN PADDY FIELD

III. TIME OF WEED ERADICATION[1]

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INTRODUCTION

In the previous experiments, the effects of weed species and population density (Chang, 1970a) and stage of weed emergence (Chang, 1970b) have been investigated. Recently, the shortage of farm labors in Taiwan has made hand weeding in paddy field increasingly difficult to proceed on schedule which may substantially affect the growth of rice plant. However, the degree of damage from this prolonged competition of weeds with rice in paddy field is not presently clear. The answer to this problem may provide useful information for the planning of an effective and economical weed control program. This paper reports the results of the third experiment undertaken to evaluate the effect of time of weed eradication on rice in paddy field.

MATERIALS AND METHODS

The experiment was conducted on the clay pots in the screen house of the Chiayi Agricultural Experiment Station in the first and second crops of 1970. Two levels of fertility, three weed species, and five different times of weed eradication were arranged in a randomized complete block design experiment with three replications. The plots were represented by individual clay pots with surface area of 314 cm^2. Low and high levels of fertility were represented by the application of 80, 40, 40 and 160, 80, 80 kg per ha of N, P_2O_5 and K_2O, respectively. Three weed species, *Echinochloa crusgalli*, *Monochoria vaginalis*, and *Cyperus difformis*, were employed to represent grassy, broadleaf, and sedge weeds, respectively. Weeds were eradicated at 15, 30, 45, and 60 days after the transplanting of rice in the first crop and at 10, 20, 30 and 40 days after transplanting of rice in the second crop respectively. A standard weed free treatment was also included for comparison.

One seedling of the rice variety, Chianung 242 was transplanted in each clay pot. Weeds were planted around rice seedling right after transplanting at the rate of three weeds per pot or about 100 weeds per m^2. The first crop was transplanted on February 25, 1970 and harvested on July 5, 1970. The second crop was transplanted on July 28, 1970 and harvested November 11, 1970. Data for grain yield and components of yield were recorded for the evaluation of weed damage to rice which was expressed in the percentage of weed-free check treatment.

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RESULTS AND DISCUSSION

The Effect of Time of Weed Eradication on Grain Yield of Rice

The grain yield of rice as affected by the time of weed eradication is given in Table 1. The average yield reduction of rice recorded for the first, second, third, and fourth eradications of weeds was 0, 16.7, 29.4, and 51.6%, respectively, showing that the degree of weed damage increased with the delay in the time of weed eradication. Difference in rice yield among times of weed eradication was significant at 1% level (Table 2) . The average percentages of yield reduction for the first, second, and third eradications were greater in high rate of fertilization treatment while that for the fourth eradication appeared slightly larger in low rate fertilization indicating that heavy fertilization favors weeds in their competition with rice during the early growing stage of rice. Thus, early weeding appears more important in paddy field with high rate of fertilization.

Table 1. Yield performance of rice in percent of weed-free treatment, 1970.

Crop Season	Time of weed eradication (DAT)*	*Echinochloa crusgalli*			*Monochoria vaginalis*			*Cyperus difformis*			Average		
		HF* (%)	LF* (%)	Mean (%)	HF (%)	LF* (%)	Mean (%)	HF (%)	LF (%)	Mean (%)	HF (%)	LF (%)	Mean (%)
First	15	109.9	115.4	112.7	96.4	110.3	103.4	112.1	108.8	110.5	106.2	111.5	108.9
	30	103.2	83.1	93.2	89.6	97.1	93.4	109.5	110.3	109.9	100.8	96.8	98.8
	45	84.2	69.9	77.1	85.1	92.7	88.9	102.3	92.7	97.5	90.5	85.1	87.8
	60	50.0	41.9	46.0	75.2	76.5	75.9	63.5	59.6	61.6	62.9	59.3	61.1
Second	10	87.9	90.4	89.2	91.2	92.7	92.0	89.3	99.3	94.3	89.5	94.1	91.8
	20	57.2	62.5	59.9	62.8	69.9	66.4	74.4	79.4	76.9	64.8	70.6	67.7
	30	45.6	52.2	48.9	39.5	58.8	49.2	64.7	58.8	61.8	49.9	56.6	53.3
	40	29.3	28.7	29.0	38.1	39.7	38.9	38.6	39.7	39.2	35.3	36.0	35.7
Average	15(10)	98.9	102.9	100.9	93.3	101.5	97.7	100.8	104.1	102.5	97.9	102.8	100.4
	30(20)	80.2	72.8	76.5	76.2	83.5	79.9	92.0	94.9	93.5	82.3	83.7	83.3
	45(30)	64.9	61.1	63.0	62.3	75.8	69.1	83.5	75.8	79.7	70.2	70.9	70.6
	60(40)	39.7	35.3	37.5	56.7	58.1	57.4	51.1	49.7	50.4	49.1	47.7	48.4

*DAT=Days after transplanting. HF=High rate of fertilization, LF=Low rate of fertilization.

Table 1 also shows that weeds eradicated at 15 days after transplanting did not cause any damage to rice but those removed at 30, 45 and 60 days after transplanting resulted in the reduction of yield by 1.2, 12.2, and 38.9%, respectively in the first crop. However, weeds eradicated at 10, 20, 30, and 40 days after transplanting in the second crop reduced

grain yield of rice by 8.2, 32.3, 46.7, and 64.3%, respectively. The crop season×time of weeds eradication was highly significant (Table 2) , indicating that damage of weeds eradicated at different stages of rice growth varied with crop seasons. In the first crop, weed growth was generally slow during the early growing stage of rice because of low temperature and competition of weeds rice is usually less severe. As a result, grain yield of rice was barely affected even though weeds were eradicated as late as 30 days after transplanting. In the second crop, however, weeds are likely to compete more effectively with rice during the early growing stage of rice since high temperature is available for the rapid growth of weeds. Consequently, weed damage became evident when eradication was made as early as 10 days after transplanting.

Table 2. Combined analysis of variance for grain yield of the first and second rice crops in 1970.

Source of variation	D.F.	S.S.	M.S.	F.	L.S.D.	
					5 %	1 %
Treatment	59	5,632.81	95.47	19.09**	1.21	1.32
Crop seasons (CS)	(1)	803.49	803.49	160.70**	3.92	6.84
Fertility levels (FL)	(1)	1,907.11	1,907.11	381.42**	3.92	6.84
Weed species (WS)	(2)	105.77	52.89	10.58**	3.07	4.78
Time of weed eradication (TWE)	(4)	2,112.97	528.24	105.65**	2.44	3.47
CS×FL	(1)	121.52	121.52	24.30**	3.92	6.84
CS×WS	(2)	0.03	0.02	0	3.07	4.78
CS×TWE	(4)	223.10	55.78	11.16**	2.24	3.47
FL×WS	(2)	32.84	16.42	3.28*	3.07	4.78
FL×TWE	(4)	84.93	21.23	4.25**	2.24	2.47
WS×TWE	(8)	112.80	14.10	2.82**	2.01	2.66
CS×FL×WS	(2)	11.16	5.58	1.12	3.07	4.78
CS×FL×TWE	(4)	34.93	8.73	1.75	2.24	3.47
CS×WS×TWE	(8)	40.47	5.06	1.01	2.01	2.66
FL×WS×TWE	(8)	23.27	2.91	0.58	2.01	2.66
CS×FL×WS×TWE	(8)	18.42	2.30	0.46	2.01	2.66
Error	116	579.76	5.00			

* Significant at 5% level. ** Significant at 1% level.

In Taiwan, farmers usually practice hand weeding 3 to 4 times in the first crop and 2 to 3 times in the second one during the whole growing period of rice. The first weeding usually begins at about 15 days after transplanting in the first crop and 10 days in the second one, then it is carried out once in every 10 and 7 days in the first and second

crops of rice, respectively. It was observed in this experiment that weeds eradicated before 30 days after transplanting affected rice yield very slightly in the first crop where as eradication made at 10 days after transplanting in the second crop resulted in a substantial reduction of rice yield. It was also indicated in the previous experiment that weeds emerged at 60 days after transplanting was still harmful to rice in the first crop, but rice yield was not affected by weeds emerged at 30 days after transplanting in the second crop (Chang, 1970b) . It appears that more effective control of weeds may be obtained for transplanted rice in Taiwan if the first hand weeding is delayed about 10 days in the first crop and advanced about 3 days in the second crop.

The damage of weeds eradicated at different times varied with weed species as reflected by a highly significant weed species× time of weed eradication interaction (Table 2) . *Echinochloa crusgalli* is an "efficient plant" (Black *et al.*,1969) which competes effectively with rice throughout the whole growing period. Thus, it is not surprising that rice suffered the heaviest damage from this weed no matter when eradication was made. Fortunately, the infestation of barnyard grass in most paddy fields of Taiwan is generally not severe (Chang, 1971) . *Monochoria vaginalis* caused more reduction of yield during the early growing stage of rice simply because this weed never grows tall and competes highly with rice only when rice plant is still small. *Cyperus difformis*, a sedge weed capable of growing as tall as rice plants, affected rice lightly when early eradications were made but heavily affected rice if eradications were delayed. The results clearly indicate that early eradication of *Monochoria vaginalis* and late weeding of *Cyperus difformis* are equally important for transplanted rice.

The Effect of Time of Weed Eradication on the Components of Yield

The average performance of yield components of rice expressed in percent of weed-free treatment is presented in Table 3. It was observed that the number of panicles per plant was more severely affected by the time of eradication in the second crop. The damage recorded for *Monochoria vaginalis* was greater in early growing stage of rice while heavier damages were recorded for late eradication *Echinochloa crusgalli* and *Cyperus difformis* in the first crop. In the second crop, however, three weeds differed slightly in their effects on the number of panicles per plant. In general, weed damage increased with the time of weed eradication.

Table 3. Average performance of yield components in percent of weed-free treatment, 1970.

Yield Component	Weed species	Fertility level*	Time of weed eradication first crop				Time of weed eradication second crop			
			15 DAT*	30 DAT	45 DAT	60 DAT	10 DAT	20 DAT	30 DAT	40 DAT
Number of panicles per plant	*Echinochloa crusgalli*	HF	110.8	78. 5	61.3	39.8	91.7	43.7	48.0	43.7
		LF	105.6	87.0	74.1	50.0	90.2	56.1	65.9	56.1

	Monochoria	HF	89.3	96.8	72.0	64.5	91.7	58.2	33.5	39.3
	vaginalis	LF	98.2	87.0	92.6	74.1	90.2	80.5	56.1	56.1
	Cyperus	HF	110.8	110.8	89.3	67.7	77.2	62.6	58.2	43.7
	difformis	LF	105.6	111.1	87.0	61.1	90.2	73.2	56.1	56.1
Number of grains per panicle	*Echinochloa*	HF	94.6	98.3	95.0	68.9	102.5	114.6	85.1	65.8
	crusgalli	LF	105.4	90.8	100.3	90.5	96.4	92.4	82.8	56.4
	Monochoria	HF	97.1	94.8	98.2	94.8	108.7	102.6	86.8	91.9
	vaginalis	LF	115.1	112.3	98.7	103.0	101.4	85.0	72.5	77.5
	Cyperus	HF	96.0	100.6	99.8	81.5	111.7	101.5	106.6	81.7
	difformis	LF	106.4	103.0	104.0	100.3	111.1	107.9	115.1	68.9
Weight of 100-grain	*Echinochloa*	HF	104.5	99.6	101.9	93.3	100.0	103.9	103.9	100.0
	crusgalli	LF	98.5	103.3	87.1	84.9	105.1	109.0	105.1	105.1
	Monochoria	HF	100.8	98.1	99.6	98.1	100.0	103.9	103.9	107.7
	vaginalis	LF	101.9	98.5	88.6	103.3	101.1	109.0	105.1	101.2
	Cyprus	HF	99.6	95.9	100.8	104.6	103.9	100.0	100.0	100.0
	difformis	LF	100.7	99.6	97.1	97.1	101.2	101.2	101.2	109.0
Percentage of fertility	*Echinochloa*	HF	100.1	99.6	99.3	95.2	100.3	102.6	101.2	99.0
	crusgalli	LF	99.7	99.6	98.7	95.9	100.0	100.6	98.3	94.1
	Monochoria	HF	99.4	97.2	100.9	100.7	101.1	99.6	102.6	101.5
	vaginalis	LF	100.2	98.8	100.7	100.5	99.5	102.4	98.2	97.4
	Cyperus	HF	100.8	103.2	99.4	100.6	101.4	101.6	99.5	99.5
	difformis	LF	100.2	100.2	100.1	100.2	100.6	99.4	99.6	98.9

*HF High rate of fertilization. LF=Low rate of fertilization. DAT=Days after transplanting.

The number of grains per panicle was affected mostly by late eradication of weeds. Weed damage was more pronounced in low rate of fertilization in the second crop. The effect of *Monochoria vaginalis* appeared less significant than those of *Echinochloa crusgalli* and *Cyperus difformis*. The weight of 100-grain and the percentage of fertility were not affected by the time of weed eradication, indicating that the reduction of grain yield of rice may be largely attributable to the decrease in the number of panicles per plant and the number of grains per panicle.

SUMMARY

The effect of time of weed eradication on rice was evaluated in both crops in 1970. Average percentages of yield reduction recorded for the first, second, third, and fourth eradications of weeds were 0, 16.7, 29.4, and 51.6%, respectively. Weeds eradicated at 15, 30, 45, 60, and 10. 20, 30, 40 days after transplanting in the first and second crops reduced yield by 0%, 1.2%, 12.2%, 38.9%, and 8.2%, 32.3%, 46.7 %, 64.3%, respectively. *Monochoria vaginalis* caused more damage to rice if early eradication was not made while *Echinochloa crusgalli* and *Cyperus difformis* reduced rice yield more severely when they were eradicated until late growing stage of rice. The damage of weeds eradicated at early growing stage of rice appeared heavier in high fertilizer treatment. The time of weed eradication affected the number of panicles per plant and the number of grains per panicle but not the weight of 100-grain and the percentage of fertility.

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水田雜草對水稻之影響

Ⅲ 雜草之拔除時期

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摘 要

嘉義農業試驗分所繼續於民國59年第１、２期作在網室內調查三種之主要水田雜草不同拔除時期對水稻爲害之情形。初步結果顯示，第１、２、３與４四種不同處理之雜草拔除時期分別減產稻谷、0、16.7、29.4與51.6%。第１期作在插秧後15、30、45與60日拔草，而第２期作則在插秧後10、20、30與40日拔草時，分別減產0、1.2、12.2與38.9及8.2、32.3、46.7與64.3%。鴨舌草若不在早期拔除時爲害較大，而稗草與三角草則延至後期拔除時較易造成嚴重爲害。一般言之，雜草之爲害以重肥區較爲嚴重。雜草拔除時期之早晚只爲害每株穗數與每穗粒數，而百粒重與稔實率則不受影響。