THE EFFECT OF WEEDS ON RICE IN PADDY FIELD

II. STAGE OF WEED EMERGENCE

W. L. Chang

Introduction

In the first experiment conducted in 1968, it was observed that the degree of damage caused by weeds in transplanted rice varied with weed species, population density, crop season and fertility level (Chang, 1970). In this experiment, weeds were planted right after the transplanting of rice with assumption that weeds emerged at the same time of rice transplanting. However, weed damage to rice may differ if weeds emerge at different rice growing stage. Early-emerging weeds are likely to cause more damage to rice when rice plants are still small, whereas late-emerging weeds may not have such heavy competition with rice because rice plants at that time are already well established. The understanding of the damage caused by weeds emerged at different rice growing stage may provide usefu information for the planning of an effective and economical weed control practice. This paper summarizes the results obtained from the second experiment which measures the effect of stages of emergence of some major weeds in transplanted rice.

Materials and Method

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 1969. Two levels of fertility, three weed species, and five stages of weed emergence 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, broadleaved and sedge weeds, respectively. Five stages of weed emergence were 15, 30, 45, and 60 days after rice transplanting in the first crop and 10, 20, 30 and 40 days after rice transplanting in the second crop, respectively, by planting four to five-leaf stage weeds at the given rice growing stages. A standand weed-free check treatment was included for comparison. Population density of weeds was three weeds per pot or about 100 weeds per m^2.

A japonica rice variety, Chianung 242 was used to evaluate weed damage on rice. One rice seedling was transplanted to each pot. The first crop was transplanted on January 31, 1969 and harvested on June 19, 1969. The second crop was transplanted on July 27, 1969 and harvested on November 2, 1969. Data for grain yield and components of grain yields were recorded for the evaluation of weed damage to rice which was expressed in percentage of weed-

free check treatment.

Results and Discussion

The Effect of Weed on Rice Yield

The average performance of rice yield in percentage of weed-free treatment is presented in Table 1. It was found that average yield of rice corresponded inversely with stages of weed emergence. Difference in rice yield among stages of weed emergence was significant at 1% level (Table 2). The percentages of yield reduction were 60.5, 29.5, 13.5, and 1.9% for the first, second, third, and fourth dates of weed emergence or at 15 (10), 30 (20), 45 (30), and 60 (45) days after rice transplanting, respectively. In the previous experiment, 72.8% reduction of yield was recorded for the same weeds emerged right after the transplanting of rice (Chang, 1970). These observations clearly indicated that early-emerging weeds tend to cause more damage to rice than that of late-emerging ones. The control of the early emerging weeds appears, therefore, more important than that of the late emerging ones.

Table 1. Yield performance of rice in the percentage of weed-free treatment.

Crop season	Stage of weed emergence (DAT) *	*Echinochloa crusgalli*			*Monochoria vaginalis*			*Cyperus difformis*			Average		
		HF* (%)	LF* (%)	Mean (%)	HF (%)	LF (%)	Mean (%)	HF (%)	LF (%)	Mean (%)	HF (%)	LF (%)	Mean (%)
First	15	13.8	15.9	14.9	49.7	57.4	53.6	30.8	20.0	25.4	31.4	31.1	31.3
	30	30.5	26.3	28.4	74.6	89.3	82.0	63.8	35.2	49.5	56.3	50.3	53.3
	45	61.1	55.9	58.5	83.8	95.2	89.5	62.9	72.6	67.8	69.3	74.6	71.9
	60	75.5	89.3	82.4	105.1	98.9	102.0	87.1	77.8	82.5	89.2	88.7	89.0
Second	10	35.3	33.9	34.6	54.5	61.7	58.1	59.4	40.3	49.9	49.7	45.3	47.5
	20	69.2	79.4	74.3	87.2	101.6	94.4	94.0	89.0	92.0	83.5	90.3	86.9
	30	103.8	106.9	105.4	91.0	108.5	96.8	98.1	96.8	97.5	97.6	104.1	100.9
	40	110.5	104.4	107.5	113.5	106.1	109.8	104.1	104.4	104.3	109.4	105.0	107.2
Average	15 (10)	24.6	24.9	24.8	52.1	59.6	55.9	45.1	30.2	37.7	40.6	38.2	39.5
	30 (20)	49.0	52.9	51.4	80.9	95.5	88.2	78.9	62.6	70.8	69.9	70.3	70.1
	45 (30)	82.5	81.4	82.0	87.4	101.9	94.7	80.5	84.7	82.7	83.5	89.3	86.5
	60 (40)	93.0	66.9	95.0	109.3	102.5	105.9	95.6	91.1	93.4	99.3	96.8	98.1

* DAT=Days after transplanting. HF=High fertility. LF=Low fertility.

The damage of rice caused by weeds varied with stage of emergence as reflected by a highly significant weed species x stage of weed emergence interaction (Table 2). Early-emerging grassy and sedge weeds found to offer more serious competition to rice than that of broad-leaved one. For example, *Echinochloa crusgalli* and *Cyperus difformis* emerging at 15 and 10 days after rice transplanting in the first and second crops, reduced grain yield of rice by 75.2, and 62.3% respectively, while only 44.1% yield reduction was observed for *Monochoria vaginalis* emerging at the same stage of rice growing (Table 1). *Echinochloa crus-*

galli and *Cyperus difformis* emerged at late tillering stage of rice 60 and 40 days after transplanting in the first and second crops were still capable of competing with rice, although the degree of weed influence was considerably smaller in comparison with that caused by weeds emerging earlier. Grain yield of rice was not affected by *Monochoria vaginalis* when it emerged at late tillering stage of rice. Significantly lower mean yields of rice were also reported for early and late competition by grasses (IRRI, 1969). Apparently, grasses and sedges can grow tall and compete highly with rice for height even they emerge late but the growth of late-emerging broadleaves tends to be suppressed by the well established rice plants. It appears therefore, that the control of grassy and sedge weeds such as *Echinochloa crusgalli* and *Cyperus difformis* should be continued up to the late-tillering stage of rice while the control of late-emerging broadleaves such as *Monochoria vaginalis* may be of no practical importance.

Table 2. Combined analysis of variance for grain yield of rice in the first and second crops of 1969.

Source of variation	D.F.	S.S.	M.S.	F	L.S.D.	
					5%	1%
Treatment	59	10,522.52	178.35	11.40*	1.21	1.32
Crop seasons (CS)	(1)	35.37	35.37	2.26	3.92	6.84
Fertility levels (FL)	(1)	556.16	556.16	35.56**	2.92	6.86
Weed species (WS)	(2)	1,002.95	501.48	32.06**	3.07	4.78
Stage of weed emergence (SWE)	(4)	6,270.47	1,567.62	100.23**	2.44	3.47
CS x FL	(1)	46.62	46.62	2.98	3.92	6.84
CS x WS	(2)	326.24	163.12	10.43**	3.07	4.78
CS x SWE	(4)	810.29	202.57	12.95**	2.24	3.47
FL x WS	(2)	53.19	26.60	1.70	3.27	4.78
FL x SWE	(4)	289.81	72.45	4.63**	2.24	3.47
WS x SWE	(8)	501.02	62.63	4.00**	2.01	2.66
CS x FL x WS	(2)	14.64	7.32	0.47	3.07	4.78
CS x FL x SWE	(4)	136.79	34.20	2.19	2.24	3.47
CS x WS x SWE	(8)	216.12	27.02	1.73	2.01	2.66
FL x WS x SWE	(8)	182.12	22.77	1.46	2.01	2.66
CS x FL x WS x SWE	(8)	80.73	10.09	0.65	2.01	2.66
Error	116	1,814.78	15.64			

** Significant at 1% level.

It was observed that weeds emerging at 15, 30, 45, and 60 days after rice transplanting reduced grain yield of rice by 68.7, 46.7, 28.1, and 11.0%, respectively in the first crop. In the second crop, however, yield reduction was recorded only for early-emerging ones. weeds emerging at 10 and 20 days after rice transplanting reduced grain yield of rice by 52.5 and 13.1% respectively, but weeds emerging at 30 and 40 days after rice transplanting did not cause any damage to

rice in the second crop. The crop seasons x stage of weed emergence was highly significant (Table 3), indicating that damage caused by weeds emerging at different stages varied with crop seasons. In the first crop, because of low temperature, the growth of rice plant is generally slow which enables late-emerging weeds to compete favorably with rice. In second crop, however, rice growth is generally stimulated by high temperature prevailing during the early growing stage which may inhibit the growth of late-emerging weeds. The degree of damage caused by weeds emerging at different stages appeared to be more or less similar under different fertility levels.

In Taiwan, it is a general pratice by hand weeding 3 to 4 times in the first crop and 2 to 3 times in the second one for transplanted rice. The first weeding usually begins at about 15 days after transplanting in the first crop and 10 days in the second one, then the second and later weeding will be done with 10- and 7-days intervals for the first and second crops of rice, respectively. This means that hand weeding ends at about 35 to 45 days after rice transplanting in the first crop and at about 17 to 24 days in the second one. Since grassy and sedge weeds emerging as late as 60 days after transplanting were found to be still capable of causing considerable damage to rice in the first crop, one more hand weeding after the fourth weeding or 45 days after transplanting may prove useful if the paddy is infested with heavy grassy and sedge weeds. In the second crop, however, the third weeding may be unnecessary as long as early-emerging weeds are properly controlled. In the case of chemical weed control, most granular herbicides such as Nitrofen or TOK, the most popular herbicide currently in use in Taiwan (Chang, 1969), are applied at 7 days after transplanting in the first crop, and 4 days in the second one, they are able to provide good control of weeds for only one month, and weeds are likely to emerge at about 37 days after transplanting in the first crop and at about 34 days in the second one. One application of chemicals or one hand weeding at the time of maximum tillering stage appears, therefore, necessary for the control of late emerging weeds in the first crop.

The Effect of Weeds on Yield Components of Rice

The average performance of the four yield components of rice expressed in the percentage of weed-free treatment is presented in Table 3. It was observed that the number of panicles per plant suffered the greatest damage, followed by the number of grains per panicle but the 100 grain-weight and the fertility percentage were not affected by weed competition, indicating that the reduction of grain yield of rice caused by weeds may be due largely to the decrease in the number of panicles per plant and the number of grains per panicle. The degree of weed damage to the number of panicles per plant and the number of grains per panicle was also found to be negatively associated with the stage of weed emergence. In the first crop, substantial damage was found for these two characters from competition of both early- and late-emerging weeds but they were affected only by early-emerging weeds in the second crop. As in the case of grain yield, both early- and late-emerging grassy and sedge weeds caused more damage to these two components than those of broadleaved one. The degree of damage caused by weeds emerged at different stages was not affected by levels of fertility.

Table 3. Average performance of yield components in the percentage of weed-free treatment.

Yield component	Weed species	Fertility level*	Stage of weed emergence, first crop				Stage of weed emergence, second crop			
			15 DAA*	30 DAA	45 DAA	60 DAA	10 DAA	20 DAA	30 DAA	40 DAA
Number of panicles per plant	*Echinochloa crusgalli*	HF	22.6	36.3	73.5	88.2	36.7	85.6	103.3	111.1
		LF	24.1	44.6	72.3	84.3	41.7	87.5	106.9	106.9
	Monochoria vaginalis	HE	61.8	68.6	98.0	98.0	52.2	92.2	107.8	107.8
		LF	60.2	84.3	96.4	100.0	69.4	90.3	97.2	97.2
	Cyperus difformis	HF	46.1	68.6	68.6	81.4	58.9	88.9	92.2	100.0
		LF	32.5	60.2	75.9	84.3	59.7	83.3	90.3	97.2
Number of grains per panicle	*Echinochloa crusgalli*	HF	53.0	58.3	84.6	86.1	71.5	88.8	99.5	100.9
		LF	63.8	63.4	74.2	103.8	65.3	95.4	110.6	101.3
	Monochoria vaginalis	HF	67.9	91.7	92.6	107.6	81.6	99.4	103.0	111.0
		LF	86.4	90.1	91.6	100.3	80.5	97.0	108.0	105.3
	Cyperus difformis	HF	55.0	80.1	87.6	94.6	77.3	105.6	105.6	104.7
		LF	63.9	70.7	88.8	87.5	62.9	100.8	102.1	102.4
Weight of 100-grain	*Echinochloa crusgalli*	HF	100.0	107.4	100.0	103.7	103.7	100.0	103.7	100.0
		LF	93.9	97.5	97.5	100.1	96.2	96.2	96.2	100.0
	Monochoria vaginalis	HF	100.0	103.7	103.7	103.7	103.7	96.3	103.7	103.7
		LF	97.5	93.9	93.9	104.7	107.7	107.7	107.7	103.9
	Cyperus difformis	HF	96.3	107.4	107.4	103.7	107.4	103.7	103.7	103.7
		LF	101.1	97.5	97.5	97.5	103.9	100.0	103.9	107.8
Percentage of fertility	*Echinochloa crusgalli*	HF	101.9	102.4	99.2	100.1	103.3	100.3	97.0	102.6
		LF	99.7	99.8	100.4	100.5	100.6	96.5	99.8	102.9
	Monochoria vaginalis	HF	102.0	100.8	101.8	100.7	100.7	98.0	100.8	101.0
		LF	99.6	99.8	101.4	100.3	103.9	103.3	100.4	103.9
	Cyperus difformis	HF	102.8	102.0	100.3	102.2	106.0	100.7	98.1	98.0
		LF	101.0	100.0	99.1	101.7	103.4	102.7	102.0	105.5

* HF=High fertility. LF=Low fertility. DAA=Days after transplanting.

Summary

The effect of weeds emerged at different stages on transplanted rice was investigated in both crops of 1969. Weeds emerged at 15, 30, 45, and 60 days after rice transplanting reduced grain yield of rice by 68.7, 46.7, 28.1, and 11.0% respectively in the first crop. In the second crop, weeds emerging at 10 and 20 days after transplanting caused yield reduction of 52.5 and 13.1% respectively, but weeds emerging at 30 and 40 days after tansplanting did not affect the grain yield of rice. Early- and late-emerging *Echinochlor crusgalli* and *Cyperus difformis* reduced more grain yield of rice than those of *Monochoria vaginalis.* The degree of damage caused by weeds emerging at different rice growing stages was not affected by fertility levels. Among components of yield, weeds affected only the number of panicles per plant and the number of grains per panicle, but not the 100-grain weight and the fertility percentage.

Literature cited

1. Chang, W. L. 1969. Progress report of rice weed control experiment and extension in Taiwan- a paper presented to the Second Asian-Pacific weed Control Interchange, The Philippines. 60-71
2. Chang, W. L. 1970. The effect of weeds on rice in paddy field. I. Weed species and population density. Jour. Taiwan Agr. 19 (4) : In press 18-25
3. The International Rice Research Institute. 1969. Annual Report, 1968. 402 pp.

水田雜草對水稻之影響

Ⅱ雜草之發生時期

張　萬　來

摘　要

嘉義農業試驗分所於民國58年第1、2期作在網室內調查三種主要水田雜草在不同時期發生時，對水稻爲害之情形。初步結果顯示在第1期作水稻，雜草若在插秧後15、30、45與60日發生時可分別減產68.7、46.7、28.1與11.0%，第2期作水稻，其產量只因插秧後10與20日發生之雜草而減產52.5與13.1%，但其產量却不受在30與40日萌發雜草之影響。早期與後期萌發之稗草與三角草影響水稻產量之程度較鴨舌草爲大。不同時期萌發之雜草在不同肥力條件下減低稻谷產量之程度相若，稻谷產量構成因素中每株穗數與每穗粒數受雜草爲害之程度最爲嚴重，而百粒重與稔實率則不受影響。