RESIDUAL EFFECT OF HERBICIDES ON THE SUCCEEDING CROP OF RICE[1]

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Recent introduction of herbicides for controlling weeds in transplanted rice in Taiwan has prompted speculation concerning the possible residual effect of these chemicals on the performance of the succeeding crops. It is a matter of great concern to rice workers in view of the rapid increase in the use of herbicides in recent years. In 1971, the acreage of chemical control of weeds in rice exceeded 50,000 ha while only 15,000 ha of rice field was controlled with herbicides in 1970 (Chang, 1971) . It appears worthwhile, therefore, to understand the role played by herbicide residues in the transplanted rice. The objectives of this investigation were to compare the infestation of weeds and the growth of rice in the paddy field treated with various herbicides in the second crop, 1971.

MATERIALS AND METHODS

This experiment was conducted in the first crop of 1972 at the Wan-tien-li farm of the Chiayi Agricultural Experiment Station. Japonica rice variety, Chianung 242 was transplanted in the paddy field which was subjected to 11 herbicide treatments in the previous crop, the second crop of 1971 (Table 1). The original experimental plots as well as experimental design were employed. The plant spacing was 25×20 cm with approximately five seedlings being transplanted in each hill. Fertilizers were applied at the rate of 120,60, and 60 kg per ha for N, P_2O_5, and K_2O, respectively. Weed count was made at one and two months after transplanting of rice. Plant height and number of tillers per hill at 60 days after transplanting, days to heading, plant height and number of panicles per hill at maturity stage and grain yield of rice were recorded for the analysis of variance.

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Table 1. Herbicide treatments of the second crop, 1971.

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

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

RESULTS AND DISCUSSION

Infestation of Weeds

The infestation of weeds expressed by the number of weeds per m^2 is presented in Table 2. It was observed that the experimental plots were infested predominantly with broadleaf weeds such as *Monochoria uaginalis* and *Lindernia pyxidaria* while the infestation of grassy and sedge weeds was relatively mild. Table 2 shows that population density of weeds varied considerably among treatments at both weed counts. The treatments of 2,4—D IPE, Benthiocarb, and C—288+2,4—D IPE were infested with smaller number of weeds while the treatments of CP 53619, Benthiocarb +2,4—D IPE, and C—290+2,4—D IPE were more heavily infested with weeds. Among treatments with less weeds, good control of weeds was obtained only by C—288+2,4—D IPE in the second crop of 1971 while adequate control of weeds was apparently available for C—290+2,4—D IPE in the treatments with heavy infestation of weeds in the first crop of 1972 (Chang and Mao, 1972) . The correlation between the average weed control rating in the second corp of 1971 and the average number of weeds per m^2 in the first crop of 1972 gave r value of-0.0389. This value is too small to attain significance, suggesting that weed control effect of herbicide treatments is not related to the degree of weed infestation in the succeeding crop. Thus, residual effect of herbicides on the weed infestation of the following rice crop is not evident in this experiment.

Table 2. Weed infestation in rice field applied with herbicides in the previous crop.

Treatment	Number of weeds per m² at 30 DAT				Number of weeds per m² at 60 DAT				Mean
	Grasses	Broad-leaves	Sedges	Total	Grasses	Broad-leaves	Sedges	Total	
1	45	[illegible]	35	610	75	960	95	1,130	870
2	65	1,430	5	1,500	60	1,330	55	1,445	1,473
3	55	1,005	155	1,215	50	1,060	230	1,340	1,278
4	60	530	80	670	75	835	120	1,030	850
5	90	1,310	70	1,470	90	1,215	115	1,420	1,445
6	25	1,135	30	1,190	25	1,670	125	1,820	1,505
7	10	940	15	965	65	620	55	740	853
8	60	580	15	655	40	1,655	75	1,770	1,213
9	30	1,055	465	1,550	35	1,095	515	1,645	1,598
10	10	1,005	65	1,080	20	1,165	65	1,250	1,165
11	80	410	0	490	70	855	80	1,005	748

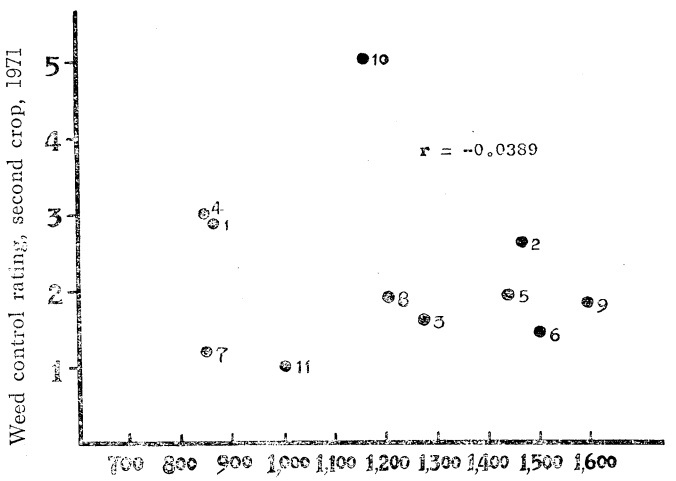

Figure 1. Relationship between average weed control rating in the second crop of 1971 and average number of weeds per m² in the first crop of 1972.

It was of interest, however, to note that the treatment of C—288+2,4—D IPE which showed the best control of weeds in the second crop of 1971 was also infested with less weeds in the first crop of 1972. It was also observed that Handweeded control gave the lowest average number of weeds per m² among 11 herbicide treatments in the first crop of 1972. This seems to indicate that certain herbicide treatments do affect the

infestation of weeds in the following crop although the degree of influence may be different. There will be less seeds produced by weeds for the propagation in the succeeding crop since most of weeds may have been killed before they reach the stage of maturity. Hence, weed population in these particular treatments with good weed control effect may be considerably reduced. It is also possible that application of certain herbicides or herbicide combinations such as C—288+2,4—D IPE at rates necessary to provide satisfactory weed control in transplanted rice may persist in amounts toxic to the growth of weeds in the following crop. Further investigation on this matter appears worthwhile.

Growth Performance of Rice

Plant height and number of tillers at 60 days after transplanting, plant height and number of panicles per hill at maturity stage, number of days from transplanting to heading, and grain yield in kilograms per hectare are shown in Table 3. Toxicity rating was not included because there was practically no trace of rice toxicity and normal growth was apparently available for rice plants in the experimental plots. There was no significant difference among herbicide treatments for plant height and number of tillers per hill recorded at 60 days after transplanting, indicating that early growth of rice plants was not affected by the herbicide treatments of the previous crop. Differences in plant height and number of panicles per hill at maturity stage, days to heading, and grain yield of rice all failed to attain significance, suggesting that growth performance of the adult rice plants in the plots previously applied with herbicides was similar to that of the non-treated ones. The results of this experiment clearly indicate that residues from the application of herbicides in the second crop may not persist in amounts toxic to the growth of rice in the following first crop. The herbicides or herbicide combinations applied in the second crop of 1971 were mostly of experimental materials except CP 53619 (Butachlor) and Benthiocarb which have been on the recommended list of commercial herbicides in Taiwan since 1970 (Lin, 1971).

Table 3. Growth performence of rice in paddy field applied with herbicides in the previous crop.

Treatment	Rice growth at 60 DAT		Rice growth at maturity stage		Days to heading	Grain yield (kg/ha)
	Plant height (cm)	Tillers per hill	Plant height (cm)	Panicles per hill		
1	52.3	13.8	106.8	11.6	97	4,437
2	50.4	13.3	107.7	11.0	99	4,688
3	52.9	13.7	107.0	12.1	98	4,367
4	54.6	13.6	108.8	11.4	99	4,329
5	53.3	13.5	108.6	11.3	100	4,331
6	50.3	13.5	105.0	11.4	98	4,678
7	51.1	11.8	106.9	11.4	99	4,478
8	50.7	12.3	105.1	10.0	98	4,333

9	51.8	12.9	108.2	11.2	99	4,359
10	53.1	13.9	108.8	11.0	99	4,330
11	50.3	12.2	106.7	11.7	98	4,328
LSD 5%	NS*	NS	NS	NS	NS	NS

*Difference not significant at 5% level.

The rice plants of this experiment were grown on the plots which received preemergence application of herbicides on the surface of paddy field in the second crop of 1971. A rapid inactivation of surface-applied herbicides appears likely because herbicides applied on the soil surface are more exposed for the photodecomposition. As soil temperature is an important factor affecting the rate of microbial activity, degradation of herbicides applied in the second crop may be greatly accelerated. In Taiwan, high temperature usually prevails in the second crop of rice. Photodecomposition and microbial decomposition are among factors reported to be associated with the persistence of soil-applied herbicides (Sheets and Danielson, 1960) . These two factors could have been largely responsible for the absence of harmful residual effect of herbicides applied in the second crop, although factors other than these two may also have played a role. This observation is, however, based on the results of only one application and it is doubtful whether continuous usage of herbicides will create a residue problem. It is also not clear that inactivation of herbicides applied in the cool first crop or used in soil-incorporated preplanting application will proceed similarly as that of soil-surface preemergence application of herbicides in the warm second crop. Additional information should be obtained to answer all these questions.

SUMMARY

The residual effects of herbicides applied in the second crop of 1971 on the infestation of weeds and the growth performance of rice in the first crop of 1972 are summarized.

The treatments of 2,4—D IPE, Benthiocarb, and C—288+2,4—D IPE were infested with smaller number of weeds while those of CP 53619, Benthiocarb+2,4—D IPE, and C—290+2,4—D IPE were more heavily infested. However, the correlation between average weed control rating in the second crop of 1971 and average number of weeds per m^2 in the first crop of 1972 gave r value of -0.0389 which was too small to attain significance. This indicates that application of herbicides does not affect appreciably the infestation of weeds in the succeeding crop of rice.

Plant height and number of tillers per hill at 60 days after transplanting, plant height and number of panicles per hill at maturity stage, days to heading, and grain yield per ha did not differ significantly among treatments. Thus, residues from the application of herbicides in the second crop of 1971 may not persist in amounts toxic to the growth of rice in the following first crop of 1972.

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稻田除草劑對後作之殘餘效果

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摘 要

本文係報告民國60年第2期作使用之稻田除草劑對民國61年第1期作水稻之發育及雜草發生之影響。

2,4—D IPE， Benthiocarb 與 C—288＋2,4—D IPE 處理之雜草數目較少，而 CP 53619，Benthiocarb＋2,4—D IPE與C—290＋2,4—D IPE 處理之雜草則較多，惟60年第2期作之平均治草效果級數與61年第1期作之平均雜草數目間之相關係數只有—0.0789， 未達顯著水準。由此設論，稻田除草劑之施用並不顯著影響其後期作稻田雜草之發生。

插秧後60日之水稻株高與每株分蘗數，成熟期之水稻株高與每株穗數、抽穗期及每公頃稻谷產量之處理間差異均不顯著。由此可知60年第 2期作施用之稻田除草劑，其在稻田土壤中之遺留量顯然不足影響其後期作水稻之正常發育。