CHEMICAL WEED CONTROL IN TRANSPLANTED WINTER RICE IN SAUDI ARABIA[1]

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Summary

Four granular and two liquid herbicides were tested in transplanted winter rice in the Al-Hassa Oasis. Among granular herbicides, benthiocarb-M and butachlor gave better control of weeds with no sustained injury to rice while nitrofen and MO-401 did not perform effectively under local conditions. Both liquid herbicides, propanil and benthiocarb, also provided adequate control of weeds but caused more crop damage than the granular herbicides. More economical control of weeds in transplanted winter rice in Saudi Arabia appears likely with the use of herbicides.

Introduction

Al-Hassa Oasis, the leading agricultural area in the Eastern Province, is the main growing area of rice (*Oryza sativa* L.) in Saudi Arabia. The traditional plant type of photoperiod-sensitive cultivars is grown by transplanting method. All rice is grown under irrigation, although the limited water supply allows only one irrigation in 7 to 10 days. As a result, weed infestation is usually severe.

Local farmers grow one crop of rice in the summer and leave much of the rice area fallow during the winter season. Multiple cropping appears economically desirable in this area because more water is available for irrigation during the winter months. The successful introduction of photoperiod-insensitive cultivars of improved plant type by the Chinese Rice Mission has removed some limitations on winter cropping of rice in Al-Hassa (Chinese Rice Mission, 1975).

Hand weeding is the traditional method of weed control in rice in Al-Hassa since labour has, in the past, been available at a relatively low price. The situation has changed considerably in recent years however, due largely to rapid industrial development and more widely available education. Farm labour has become scarce and the cost is increasing. Current figures indicate that hand weeding costs S. R. 20 or about U. S. $ 5.7 per day in Al-Hassa. The use of herbicides seems to be a cheaper alternative to this increasingly expensive hand weeding of transplanted rice.

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Chemicals have never been tested for weed control in rice in Al-Hassa and information regarding herbicidal performance in the area is lacking. A chemical weed control experiment was initiated therefore in the winter crop of 1975 with the objective of evaluating several herbicides for their effects on the control of weeds and the growth of rice in Saudi Arabia. This paper summarizes the results obtained from this experiment.

Materials and methods

The field experiment was conducted in the winter crop of 1975 at Holeila, Al-Hassa, on an old saline soil. Six herbicides, including four granules (G) and two liquids or emulsifiable concentrates (EC) were applied at 10 and 11 days respectively after the transplanting of rice variety Si-pi 602106 (Chianung-sen-yu 12), a semi-dwarf, photoperiod-insensitive indica variety developed at the Chiayi Agricultural Experiment Station in Taiwan. The four granular herbicides were nitrofen (2, 4-dichlorophenyl-4-nitro-phenyl ether), MO-401 or CNP+MCPA (2, 4, 6-trichlorophenyl-4-nitrophenyl ether+2-methyl-4-chlorophenoxy acetic acid), butachlor (N-(butoxymethyl)-2-chloro-2′, 6′-diethylacetanilide) and benthiocarb-M or benthiocarb+CNP (S-(4-chlorobenzyl)-N, N-diethylthiol carbamate+2, 4, 6-trichlorophenyl-4-nitrophenyl ether). The two liquid herbicides were propanil (3, 4-dichloro-propionanilide) and benthiocarb (S-(4-chlorobenzyl)-N, N-diethyl-thiol carbamate). Both 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 2×5m and each plot consisted of eight rows of rice. The plant spacing was 25×20 cm with approximately 10 seedlings being transplanted at each hill. Immediately after transplanting, seed of barnyard grass (*Echinochloa crusgalli* (L.) beauv.) was broadcast in all plots at the rate of 5 kg per ha to ensure uniform weed density in each plot. The plots received 200 kg of N and 100 kg of P_2O_5 per ha in the form of urea and triple superphosphate respectively. Other management practices, such as disease and insect controls, were at the optimum levels.

At 15 and 30 days after the application of herbicides, the treatments were rated for their effects on weed control and on rice toxicity based on an arbitrary scale of 0 to 10. Scale 0 indicates either no control of weeds or no toxicity of rice while scale 10 indicates either excellent control of weeds or complete kill of rice plants. Data were recorded also for plant height and number of tillers per hill at 50 days after transplanting, number of panicles per hill, dry weight of weeds and grain yields. The data for grain yield and number of panicles per hill were subjected to the analyses of variance and the correlation coefficient between these two characters was also calculated.

The experiment was transplanted on 14 March 1975 and harvested on 2 July 1975.

Results and discussion

Weed control

The experimental plots were infested predominantly by *Echinochloa crusgalli* with other species *Chenopodium plaucum* L., *Eclipta prostrata* L. and *Cyperus rotundus* L. occurring sporadically. Granular benthiocarb-M was found to provide the best initial control

of weeds among the herbicide treatments (Table 1). The weed control rating at 30 days after application and dry weight of weeds measured at the time of harvesting further demonstrated that the weed control effect of granular benthiocarb-M lasted long enough to cause a substantial reduction in the growth of weeds. The average dry weight of weeds was 70 gm/m² for granular benthiocarb-M which ranked lowest among herbicide treatments and comparable to the 40 gm/m² from the treatment of hand weeding (Table 1). Weed control effects of the two emulsifiable concentrates, benthiocarb and propanil, and granular butachlor were also satisfactory, while those of granular MO-401 and nitrofen were relatively poor (Table 1). Good weed control of granular benthiocarb and butachlor in transplanted rice was also reported in Taiwan (Chang and De Datta, 1972) and in Philippines (De Datta, 1972) .

Table 1. Weed control effect of herbicides, winter crop, 1975

Treatment	Rate (kg ai/ha)	Weed control rating[1]		Dry weed weight at harvesting (g/m²)
		15 DAA[2]	30 DAA	
7.7% nitrofen G	2.3	6.5	5.5	673
8.7% MO-401 G	2.6	7.5	6.8	463
5% butachlor G	1.5	8.4	7.8	230
13% benthiocarb-M G	3.9	9.3	8.8	70
35% propanil EC	1.4	8.2	7.2	445
50% benthiocarb EC	4.0	8.8	8.0	73
Handweeded control	—	10.0	10.0	40
Unweeded control	—	0	0	1,108

1. 0=no control, 10=excellent control.
2. DAA=days after application.

The temperature prevailing immediately after transplanting was very low. The average minimum temperature was only 12°C in March and this apparently caused a delay in the establishment of transplanted rice seedlings. For this reason, the herbicides were not applied until 10 to 11 days after transplanting when some grassy weeds already reached 2-3 leaf stage of growth. This delay in the application might have led to some reduction in the weed control effect of the herbicides, particularly granular nitrofen and butachlor. Weed control of granular butachlor is highly dependent on the timing of application and it can be highly selective in controlling weeds when applied at the pre-or very early-emergence stage of weed growth (Chang and De Datta, 1972). In Taiwan, where the temperature at the time of transplanting for the first crop (the equivalent of the winter crop in Saudi Arabia) is usually several degrees higher than that of Al-Hassa, the recommended time of application of herbicides ranges from 3 to 5 days after transplanting for granular butachlor, 4 to 6 days for granular nitrofen and 6 to 8 days for granular MO-401 and benthiocarb-M(Taiwan Provincial Department of Agriculture and Forestry, 1974).

A continuous flooding of the rice field for at least 3 to 5 days after herbicide application is generally required to improve the performance of granular herbicides in transplanted rice. In the present experiment, however, this requirement was difficult to be met because prolonged water percolation into the soil and inadequate water supply rendered continuous flooding of the rice impossible. The performance of herbicides might therefore be affected by the difficulty of flooding during the early days of herbicide application. Nevertheless, weed control effects of certain herbicides such as benthiocarb-M were rated as satisfactory under this condition, suggesting that these herbicides can function normally even without the covering of water immediately after their application.

Rice toxicity

Rice toxicity ratings made at 15 and 30 days after the application of herbicides are presented in Table 2. It can be seen that liquid herbicide propanil caused the heaviest initial injury to rice, followed by another liquid herbicide benthiocarb. Rice toxicity of the granular herbicides was relatively light in comparison with that of liquid herbicides. Among four granular herbicides, nitrofen and butachlor appeared to be more toxic to rice plants than MO-401 and benthiocarb-M. Slight injury of rice caused by granular butachlor has also been observed (Chang *et al.*, 1971; Chang and De Datta, 1972).

Table 2. Rice toxicity of herbicides, winter crop, 1975

Treatment	Rate (kg ai/ha)	Rice toxicity rating[1]		Rice growth (50 DAT[3])	
		15 DAA[2]	30 DAA	Plant height (cm)	Tillers per hill
7.7% nitrofen G	2.3	1.5	0	46.0	23.0
8.7% MO-401 G	2.6	0.3	0	49.8	22.8
5% butachlor G	1.5	1.0	0.7	45.3	24.8
13% benthiocarb-M G	3.9	0.5	0.2	48.8	26.0
35% propanil EC	1.4	3.3	1.5	44.8	20.8
50% bentiocarb EC	4.0	2.2	0.5	46.3	23.5
Handweeded control	—	0	0	49.5	24.8
Unweeded control	—	0	0	46.5	21.5

1. 0=no toxicity, 10=complete kill.
2. DAA=days after application.
3. DAT=days after transplanting.

Initial rice toxicity was manifested mostly by the stunting of growth. Some heavily affected plants eventually died, resulting in missing hills. However, rice plants were mostly able to recover from the initial injury caused by herbicides, as reflected by the rice toxicity ratings made at 30 days after the application of herbicides. Except for propanil, practically no sign of physical injury was visible (Table 2). Nevertheless, rice growth in the plots with heavier initial injury appeared poorer than that of less affected treatments as evidenced from the plant height and number of tillers measured at 50 days after trans-

planting (Table 2). Rice plants in the plots of propanil gave the shortest plant height and the least number of tillers while the growth of rice plants in the plots treated with granular benthiocarb-M was comparable to that of hand weeding. This indicates that the residual effect of chemical injury to rice continues to influence the growth of rice as late as 50 days after transplanting. In Taiwan, no trace of chemical injury caused by granular butachlor is usually detected at 50 days after transplanting (Chang and De Datta, 1972).

Grain yield

All herbicide treatments significantly outyielded the unweeded control but yielded lower than the handweeded one (Table 3). With the exception of granular benthiocarb-M, differences in grain yield between herbicide treatments and the handweeded control were significant at the 5 per cent level (Table 3). Among herbicide treatments, granular benthiocarb-M gave the highest yield which was significantly higher than that of propanil and nitrofen but not of the other three herbicides. Handweeded control recorded the highest yield of 7,025 kg per ha which was followed by 6,413 kg per ha produced by granular benthiocarb-M. The unweeded treatment gave the lowest yield of 3,675 kg per ha which was 47.7 per cent lower than that of handweeded treatment. This indicates that heavy weed infestation has caused a substantial reduction in the yield of rice. The yield loss due to weed competition in the present study was much higher than the 31.4 per cent recorded by Chang and De Datta (1972) in Taiwan.

Table 3. Grain yield and number of panicles per hill, winter crop, 1975

Treatment	Rate (kg ai/ha)	Grain yield [1]		Panicles per hill [1]
		Kg/ha	%	
7.7% nitrofen G	2.3	4,975 ^{d}	70.8	16.4 ^{d}
8.7% MO-401 G	2.6	5,700 ^{bcd}	81.1	18.0 ^{c}
5% butachlor G	1.5	5,838 ^{bc}	83.1	18.9 ^{ab}
13% benthiocarb-M G	3.9	6,413 ^{ab}	91.4	19.0 ^{ab}
35% propanil EC	1.4	5,238 ^{cd}	74.6	17.7 ^{c}
50% benthiocarb EC	4.0	5,675 ^{bcd}	80.8	18.3 ^{bc}
Handweeded control	—	7,025 ^{a}	100	19.1 ^{a}
Unweeded control	—	3,675 ^{e}	52.3	14.6 ^{e}
C. V. (per cent)	—		8.57	8.35

1. For each character, any two means with a common letter are not significantly different at the 5 per cent level.

Higher grain yields were closely associated with more panicles/m_2 ($r=0.941^{**}$), indicating that the increase in the number of panicles per unit area has contributed to the increase in grain yield of rice. The treatments with lower weed control or high rice toxicity ratings or both, generally yielded less (Table 3), showing that poor weed control or severe crop injury, or both has caused reduction of grain yield.

The results indicate that granular benthiocarb-M appears promising for use in trans-

planted winter rice in Al-Hassa. Currently, granular benthiocarb-M costs only S. R. 200 or U. S. $ 60 per ha which compares favorably with the cost of hand weeding in Al-Hassa. It is estimated that hand weeding one ha of rice requires about 100 man-days which, at a cost of approximately S. R. 2,000 or U.S.$ 600, is about 10 times higher than the cost of chemical weed control. Although the yield of granular benthiocarb-M was 8.6 per cent lower than that of handweeded control, the large saving in labour cost may be sufficient enough to compensate for the reduction of yield caused by the application of this herbicide. It appears, therefore, that the use of herbicides could be more economical than the traditional hand weeding of rice in Al-Hassa. Further investigations are necessary, however, before their use is recommended to farmers.

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中 文 摘 要

本文係報告四種粒劑及兩種乳劑除草劑在 Al-Hassa 綠洲冬季移植稻田之治草試驗結果。在粒劑除草劑中，掃丹—M與馬上除兩種之藥效較佳，又無明顯藥害，惟多谷與益歐粒劑之表現則欠理想。思登與掃丹乳劑之治草效果亦佳，惟其藥害亦較嚴重。初步結果顯示沙烏地阿拉伯冬季移植稻田之經濟使用除草劑似屬可能。

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