IX. EFFECT OF PROPANIL ON PHOTOSYNTHESIS AND RESPIRATION OF SELECTED THAI RICE VARIETIES AT INITIAL GROWTH STAGE

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1. Introduction

Propanil (3,4-dichloropropionanilide) is widely used as postemergence herbicide. It controls gramineous weeds in paddy rice field such as Echinochlor crus-galli, Ischaemum rugosum, Leptochlor chinensis. Hofstra (11) found that carbondioxide uptake by common lambsquarters(Chenopodium album) was completely inhibited within 20 minutes after spraying with propanil of 3.45×10^{-3}M. Our previous research (VIII) clarified a differential response of several Thai rice varieties to herbicides; phytotoxcities were greatly different among varieties.

The present study was conducted to determine the selectivity of propanil between rice and barnyardgrass. Although many researches were conducted on selectivity of propanil, our experiment was focused on varietal difference in inhibition or stimulation of photosynthesis and respiration by propanil.

2. Material and method

Three rice varieties RD-21,RD-23 and Nihonbare plus a gramineous weed, barnyardgrass (Echinochloa crus-galli) were grown in plastic pots (30x20cm) filled with paddy soil. In green house, day and night temperature were recorded at 35°C and 23°C, relative humidity in day and night were 50% and 104%, respectively.

Propanil was sprayed to the seedlings of 2.5~2.8 leaf stage of rice (10 days after emergence) and 2.0~2.5 leaf stage of barnyardgrass (8 days after emergence), at the rate of 0.5,1.0 and 2.0 a.i.Kg/ha. The dry weight of shoot was taken 7 days after treatment.

The effect of propanil on respiration and photosynthesis was determined at 30°C by the conventional Warburg method reported by Umbreit et al. (43).

3. Result and discussion

Effect of propanil on the initial growth of RD-21,RD-23, Nihonbare and barnyard grass were shown in Figure IX-1.

Rate of 0.5-2.0 kg a.i./ha did not significantly reduce shoots weight of rice plants at 7 days after treatment , but caused phytotoxicity. It was observed that increasing propanil concentration from 1.0 to 2.0 kg a.i./ha increased phytotoxicity of RD-23, while RD-21 was slighty injured and Nihonbare was tolerant. Barnyard grass was very susceptible to propanil at 2-2.5 leaf stage. At the rate of 1-2 kg a.i./ha, the symptom of burning appeared on leaves within 1 day after spraying and the plants were completely killed in 3 to 5 days. Effect on respiration. The effect of propanil on respiration of RD-21,RD-23, Nihonbare and barnyardgrass was shown in Figure IX-2,3,4,5 and Table IX-1. There were no significant differences in oxygen uptake of all rice varieties, but oxygen uptake of barnyard grass was significantly reduced. At lower concentration of 0.5 kga.i./ha oxygen uptake of barnyard grass was reduced 50-80% within 6 days after treatment. At higher concentration the oxygen uptake of plants were reduced to zero in 3 to 6 days. Oxygen uptake by rice leaves was slightly fluctuated but the amount of oxygen uptake was not much different among rice varieties. All the rice plants recovered to normal levels in 3 to 6 days after spraying.

The difference between Nihonbare (tolerant) and RD-23 (moderately susceptible) to propanil was not observed in respiration. Effect on photosynthesis. Figure IX-6,7,8,9 and Table IX-2 shows the inhibition of photo-

-synthesis 1 hour to 3 days after propanil spray at the rate of 0.5-2 kg a.i./ha. The oxygen evolution was variably reduced 20-66% in all rice varieties. At low concentration 0.5 kg a.i./ha, oxygen evolution of rice plants was slightly inhibited in the first 24 hours and began to recover after that time. Higher concentration of 1-2 kg a.i./ha extremely reduced oxygen oxygen evolution of RD-21 and RD-23, whereas Nihonbare was moderatel reduced in oxygen evolution. However, 2 days after treatment, RD-21 and Nihonbare began to recover to normal levels, while RD-23 was still approximately 40 % compared with control. Propanil at the rate of 0.5-2.0 kg a.i./ha strongly inhibited the oxygen evolution of barnyard grass, approximately 80-90% 1 hour after spraying. At higher concentration of 1-2 kg a.i./ha, oxygen evolution was reduced to zero within 3 days and no recovery was noted, the plants was completely killed in 3 to 5 days after spraying.

The varietal difference in response to propanil was confirmed by growth test and measurement of oxygen evolution. Further studies on propanil hydrolyzing enzyme (rice arylacylamidase I) are required to elucidate these varietal differences.

Summary

Propanil at the rate of 0.5-2 kg a.i./ha was applied to 2.5-2.8 leaf stages to rice plants; RD-21,RD-23 and Nihonbare. Shoot weight of plants were not reduced at 7 days after sproying but RD-23 was moderately injured, whereas RD-21 and Nihonbare were tolerent. At 1-2 kg a.i./ha, barnyard grass was killed within 5 days. Oxygen uptake of three rice varieties were not inhibited by propanil but that of barnyardgrass was strongly inhibited and was reduced

to zero within 3 days at the rate of 2 kg a.i./ha. Oxygen evolution of RD-21,RD-23,Nihonbare and barnyard grass were significantly affected by propanil. Oxygen evolution of RD-21 and Nihonbare were severely inhibited within 2 days after spraying and recovered to normal within 6 days, whereas RD-23, suseeptible was still inhibited. Oxygen evolution of barnyard grass was completely inhibited within 2 days at 2 kg a.i./ha.

Table IX-1. Effect of propanil on respiration of leaves in selected rice varieties and <u>Echinochloa crusgalli</u>.

Rice varieties and weed	Propanil (kg a.i./ha)	$^{a}O_2$-uptake (ul/30min/mg dry weight)				
		1 hr*	1 day*	2 days*	3 days*	6 days*
RD 21	0	0.160^{a} (100)	0.131^{a} (100)	0.138^{a} (100)	0.125^{a} (100)	0.100^{a} (100)
	0.5	0.141^{a} (88)	0.121^{a} (91)	0.122^{a} (88)	0.107^{a} (85)	0.114^{a} (85)
	1.0	0.141^{a} (87)	0.120^{a} (91)	0.120^{a} (87)	0.101^{a} (81)	0.118^{a} (81)
	2.0	0.166^{a} (103)	0.132^{a} (100)	0.117^{a} (84)	0.100^{a} (80)	0.114^{a} (80)
RD 23	0	0.140^{a} (100)	0.161^{a} (100)	0.174^{a} (100)	0.176^{a} (100)	0.146^{a} (100)
	0.5	0.162^{a} (115)	0.142^{a} (88)	0.172^{a} (98)	0.188^{a} (106)	0.145^{a} (99)
	1.0	0.159^{a} (113)	0.174^{a} (108)	0.147^{a} (84)	0.157^{a} (89)	0.145^{a} (98)
	2.0	0.179^{a} (127)	0.128^{a} (79)	0.122^{a} (70)	0.137^{a} (77)	0.143^{a} (98)
Nihonbare	0	0.187^{a} (100)	0.172^{a} (100)	0.150^{a} (100)	0.164^{a} (100)	0.163^{a} (100)
	0.5	0.161^{a} (86)	0.143^{a} (83)	0.135^{a} (89)	0.167^{a} (104)	0.162^{a} (99)
	1.0	0.170^{a} (90)	0.164^{a} (94)	0.112^{a} (74)	0.151^{a} (94)	0.162^{a} (99)
	2.0	0.178^{a} (95)	0.135^{a} (78)	0.103^{a} (76)	0.172^{a} (107)	0.173^{a} (105)
<u>E. crusgalli</u>.	0	0.417^{a} (100)	0.385^{a} (100)	0.359^{a} (100)	0.258^{a} (100)	0.209^{a} (100)
	0.5	0.242^{b} (58)	0.219^{b} (56)	0.211^{b} (58)	0.103^{b} (40)	0.056^{b} (20)
	1.0	0.219^{b} (52)	0.188^{b} (48)	0.184^{b} (51)	0.034^{c} (13)	0
	2.0	0.206^{b} (44)	0.089^{c} (23)	0.072^{c} (20)	0	0

Values in the same column followed by the same letter are not significantly different at 5% level.

* Times after treatment.

Values in parenthis indicate % of control in each rice varieties or weeds.

Table IX-2. Effect of propanil on photosynthesis of leaves in selected rice varieties and *Echinochloa crusgalli*.

Rice varieties and weed	Propanil (kg a.i./ha)	$^{a}O_2$-evolution (ul/30min/mg dry weight) 1 hr*	1 day*	2 days*	3 days*	6 days*
RD 21	0	0.444^{a} (100)	0.459^{a} (100)	0.486^{a} (100)	0.487^{a} (100)	0.805^{a} (100)
	0.5	0.326^{a} (73)	0.236^{b} (51)	0.352^{a} (75)	0.398^{a} (81)	0.709^{a} (88)
	1.0	0.201^{b} (45)	0.085^{b} (18)	0.312^{b} (66)	0.374^{a} (76)	0.692^{a} (85)
	2.0	0.183^{b} (41)	0.012^{b} (2)	0.160^{c} (34)	0.364^{a} (74)	0.635^{a} (78)
RD 23	0	0.794^{a} (100)	0.669^{a} (100)	0.791^{a} (100)	0.822^{a} (100)	0.622^{a} (100)
	0.5	0.675^{a} (95)	0.536^{a} (80)	0.620^{a} (78)	0.627^{a} (76)	0.502^{a} (80)
	1.0	0.604^{a} (82)	0.550^{a} (75)	0.593^{a} (75)	0.589^{a} (71)	0.490^{a} (78)
	2.0	0.245^{b} (34)	0.379^{b} (56)	0.128^{b} (16)	0.315^{b} (38)	0.351^{b} (56)
Nihonbare	0	0.639^{a} (100)	0.808^{a} (100)	0.752^{a} (100)	0.566^{a} (100)	0.529^{a} (100)
	0.5	0.373^{b} (58)	0.666^{a} (82)	0.700^{a} (93)	0.526^{a} (92)	0.497^{a} (93)
	1.0	0.358^{b} (56)	0.447^{b} (55)	0.542^{a} (72)	0.422^{a} (74)	0.455^{a} (86)
	2.0	0.310^{b} (48)	0.409^{b} (50)	0.419^{b} (55)	0.399^{a} (70)	0.450^{a} (85)
E. crusgalli.	0	1.362^{a} (100)	1.383^{a} (100)	1.319^{a} (100)	1.265^{a} (100)	1.276^{a} (100)
	0.5	0.293^{b} (21)	0.382^{b} (27)	0.130^{b} (10)	0.032^{b} (2)	0
	1.0	0.161^{b} (12)	0.266^{b} (19)	0.065^{b} (5)	0.012^{b} (.9)	0
	2.0	0.151^{b} (11)	0.158^{b} (11)	0	0	0

Values in the same column followed by the same letter are not significantly different at 5% level.

* Times after treatment.

Values in parenthis indicate % of control in each rice varieties or weeds.

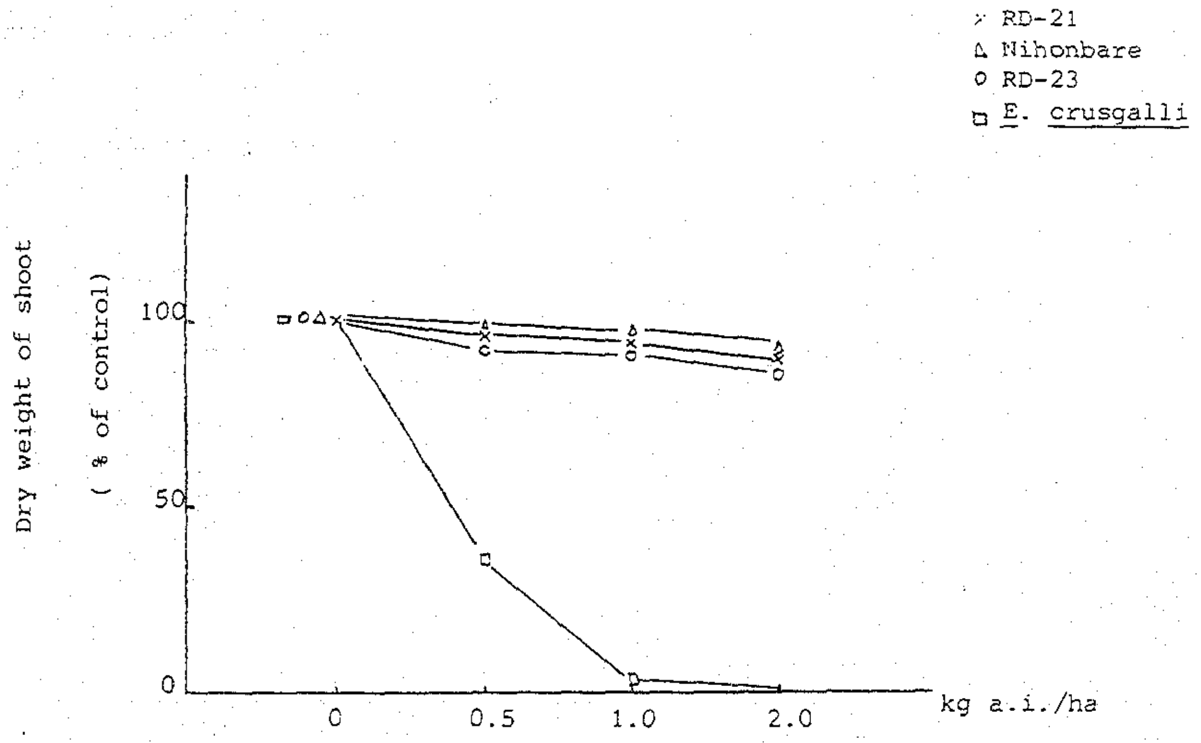

Figure IX-1. Effect of propanil on the initial growth of selected rice varieties and *E. crusgalli*.

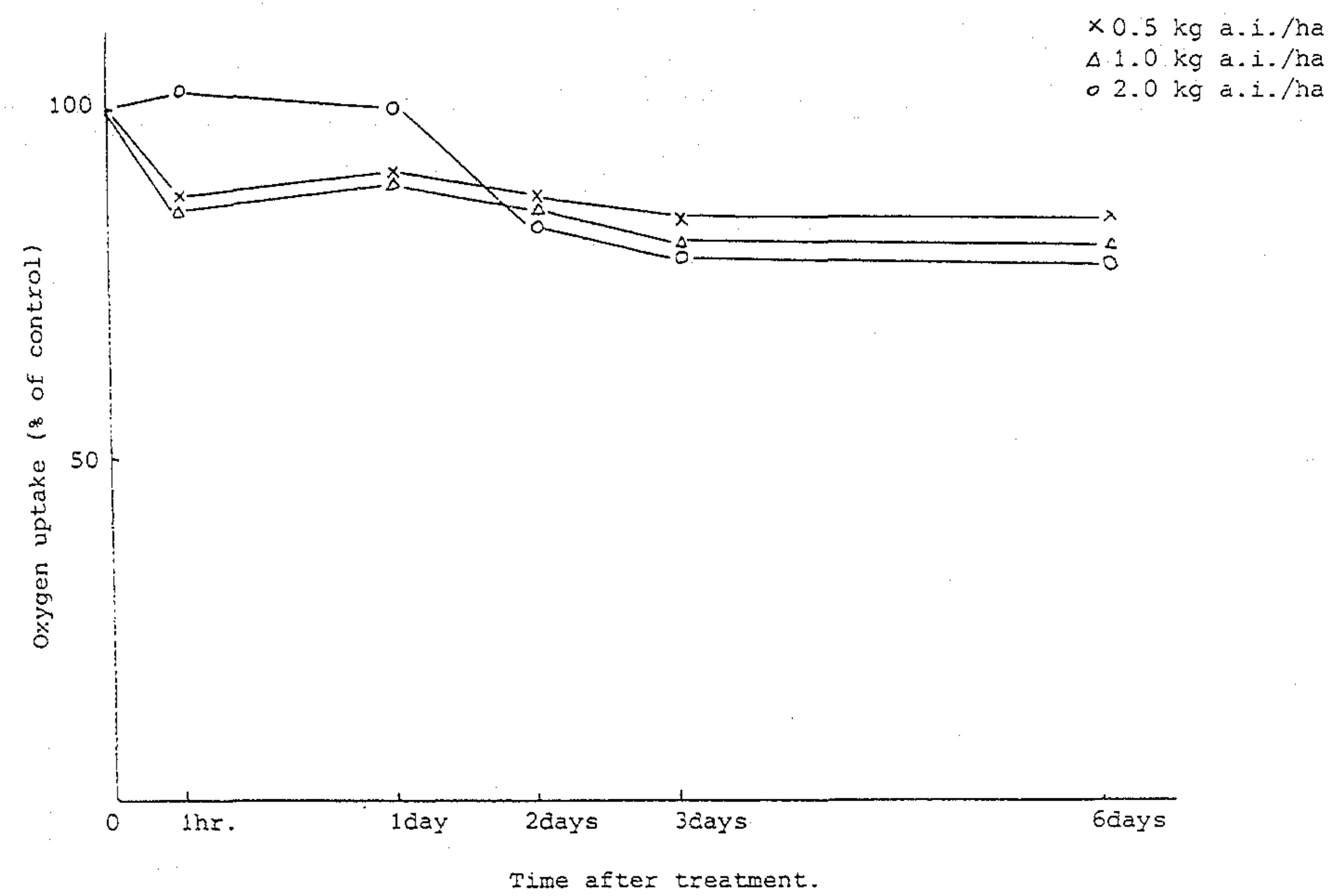

Figure IX-2. Effect of propanil on the Oxygen uptake of the leaves of RD-21.

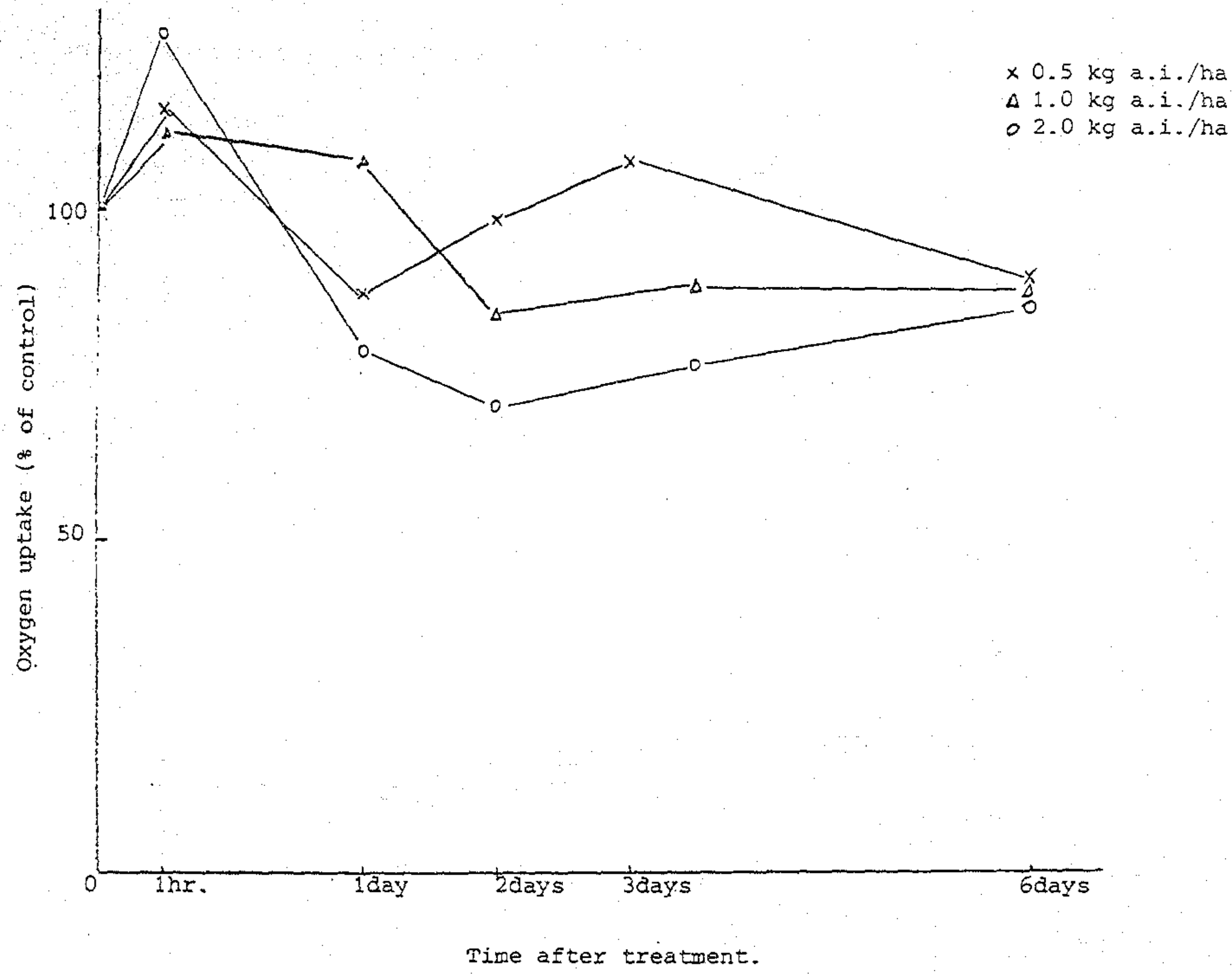

Figure IX-3. Effect of propanil on the Oxygen uptake of the leaves of RD-23.

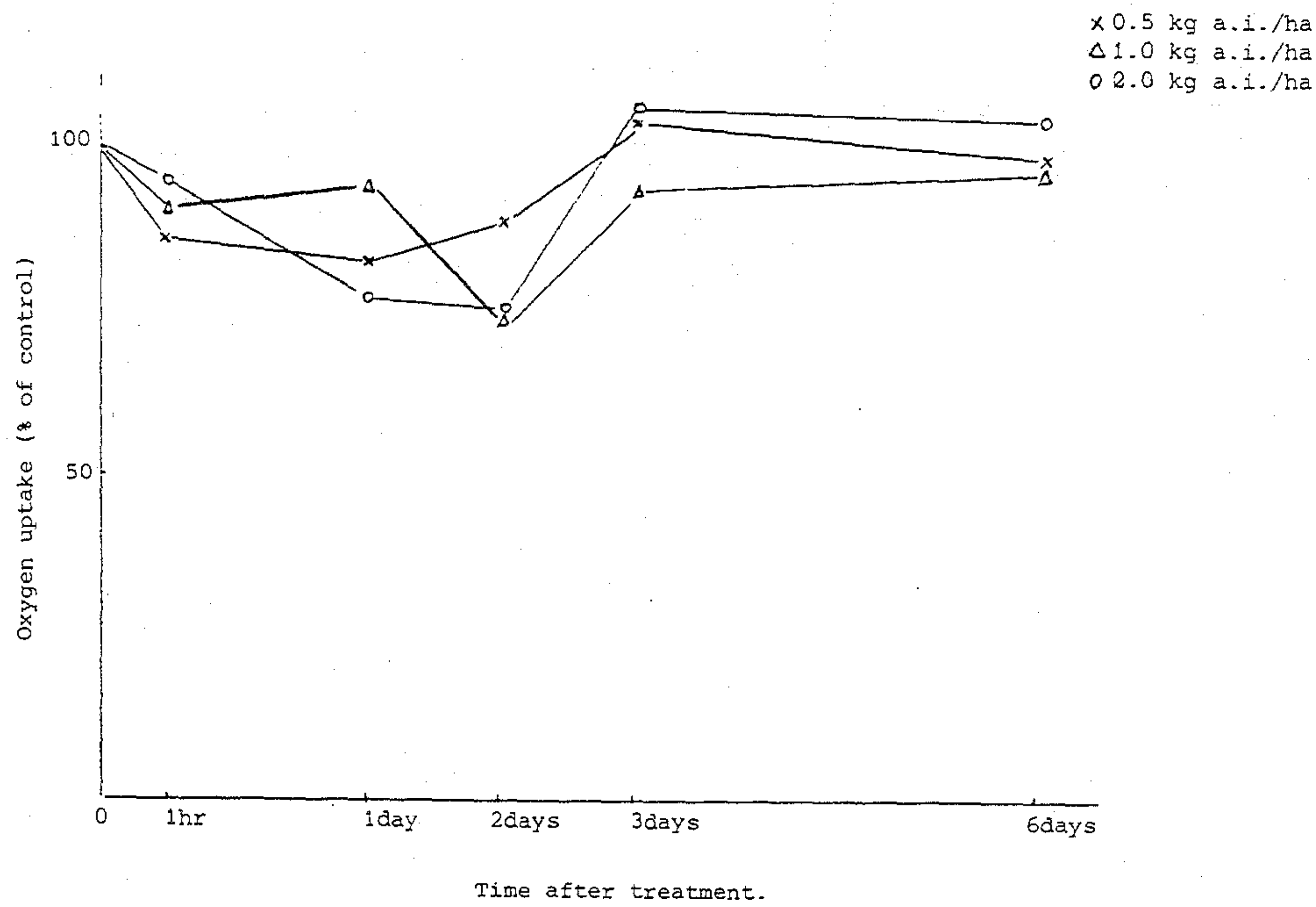

Figure IX-4. Effect of propanil on the Oxygen uptake of the leaves of Nihonbare.

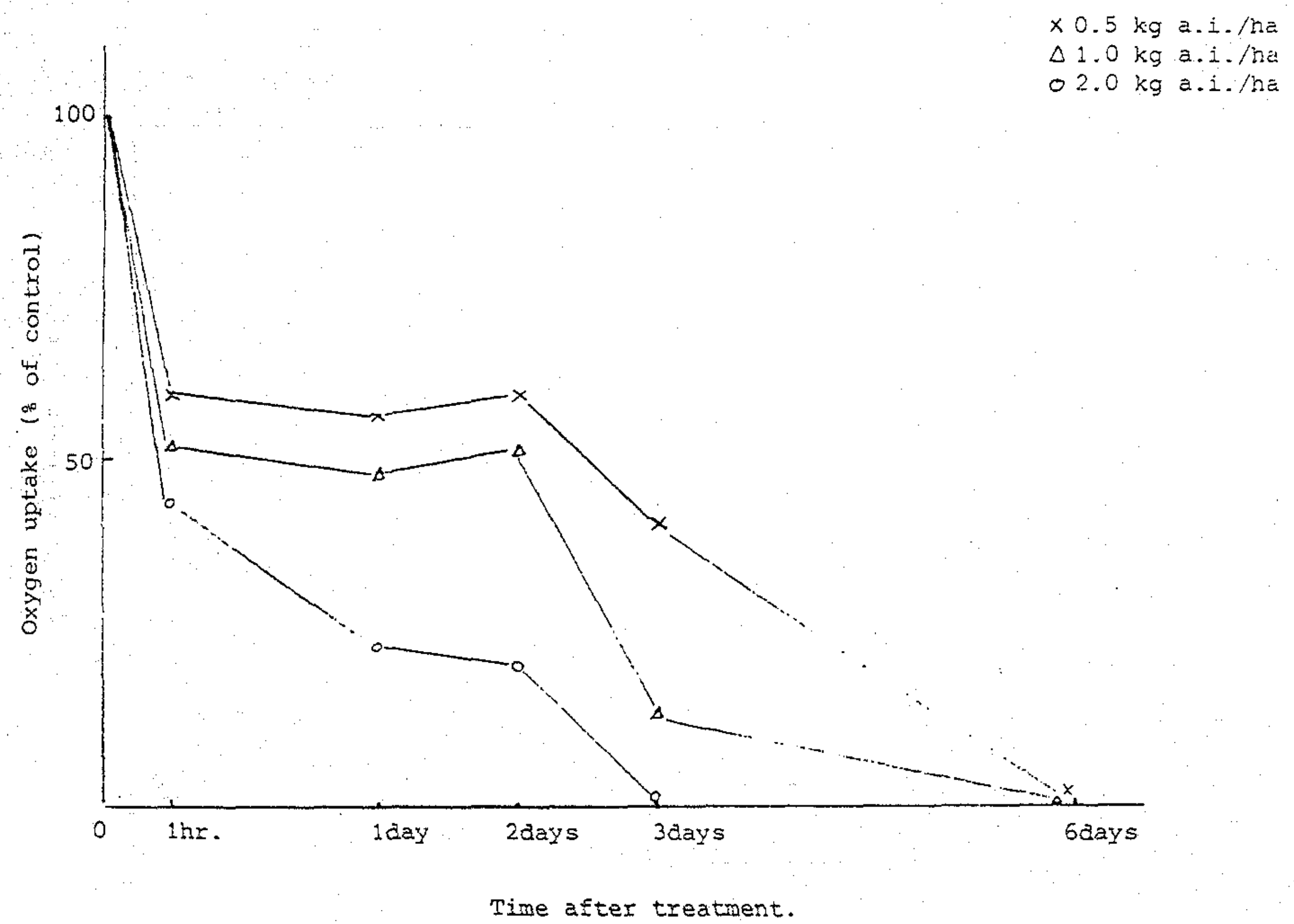

Figure IX-5. Effect of propanil on the Oxygen uptake of the leaves of <u>Echinochloa crusgalli</u>.

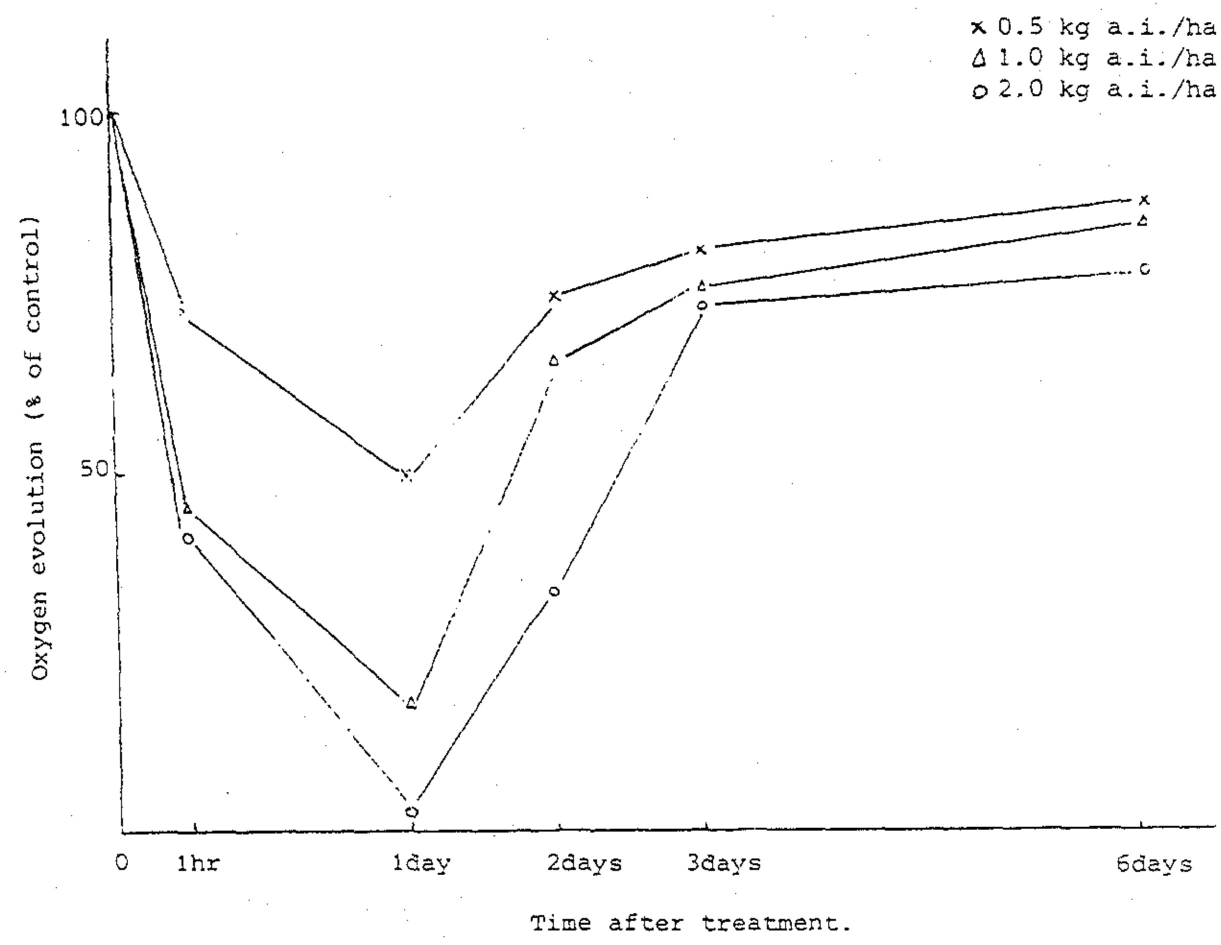

Figure IX-6. Effect of propanil on the Oxygen evolution of the leaves of RD-21.

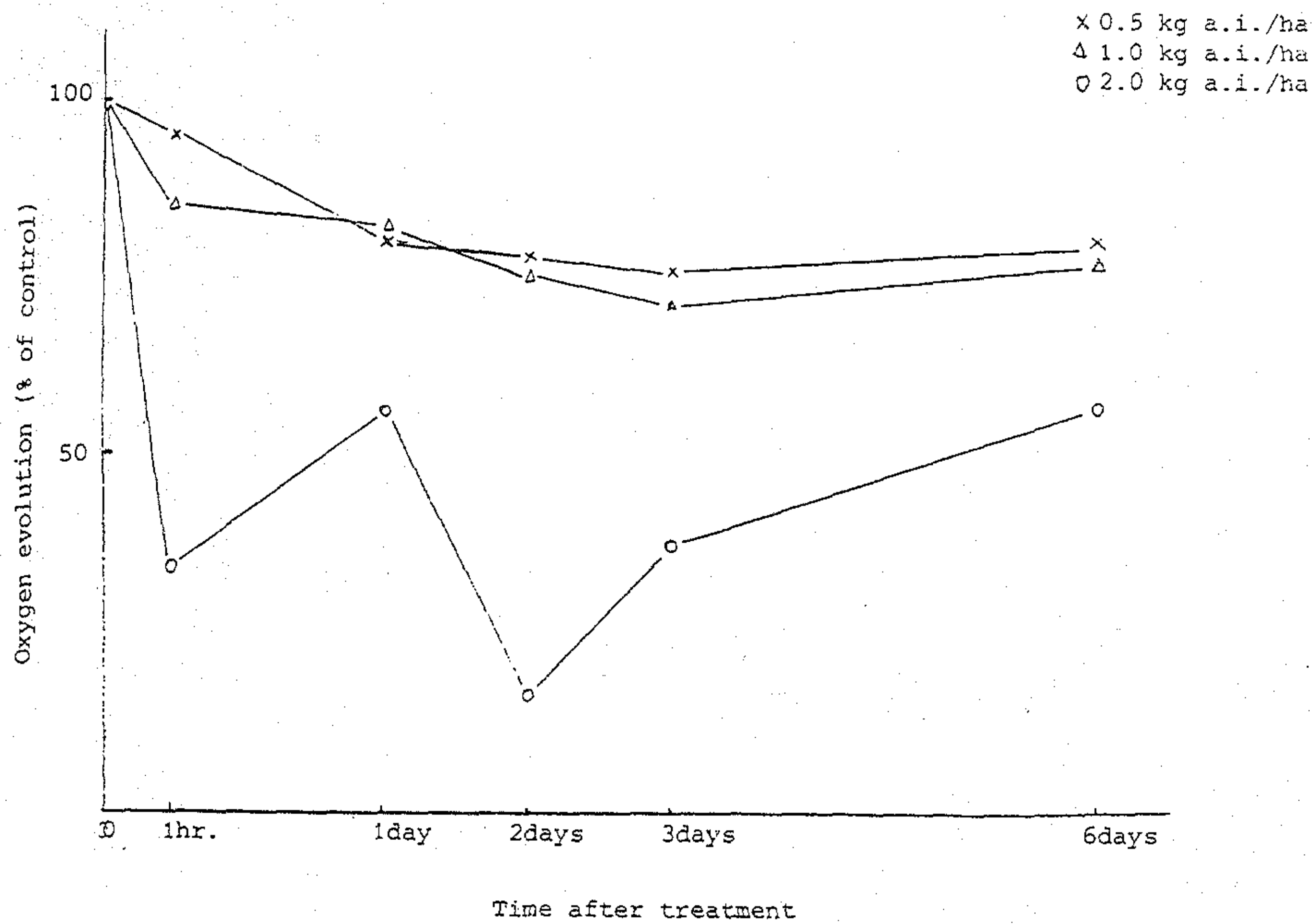

Figure IX-7. Effect of propanil on the Oxygen evolution of the leaves of RD-23.

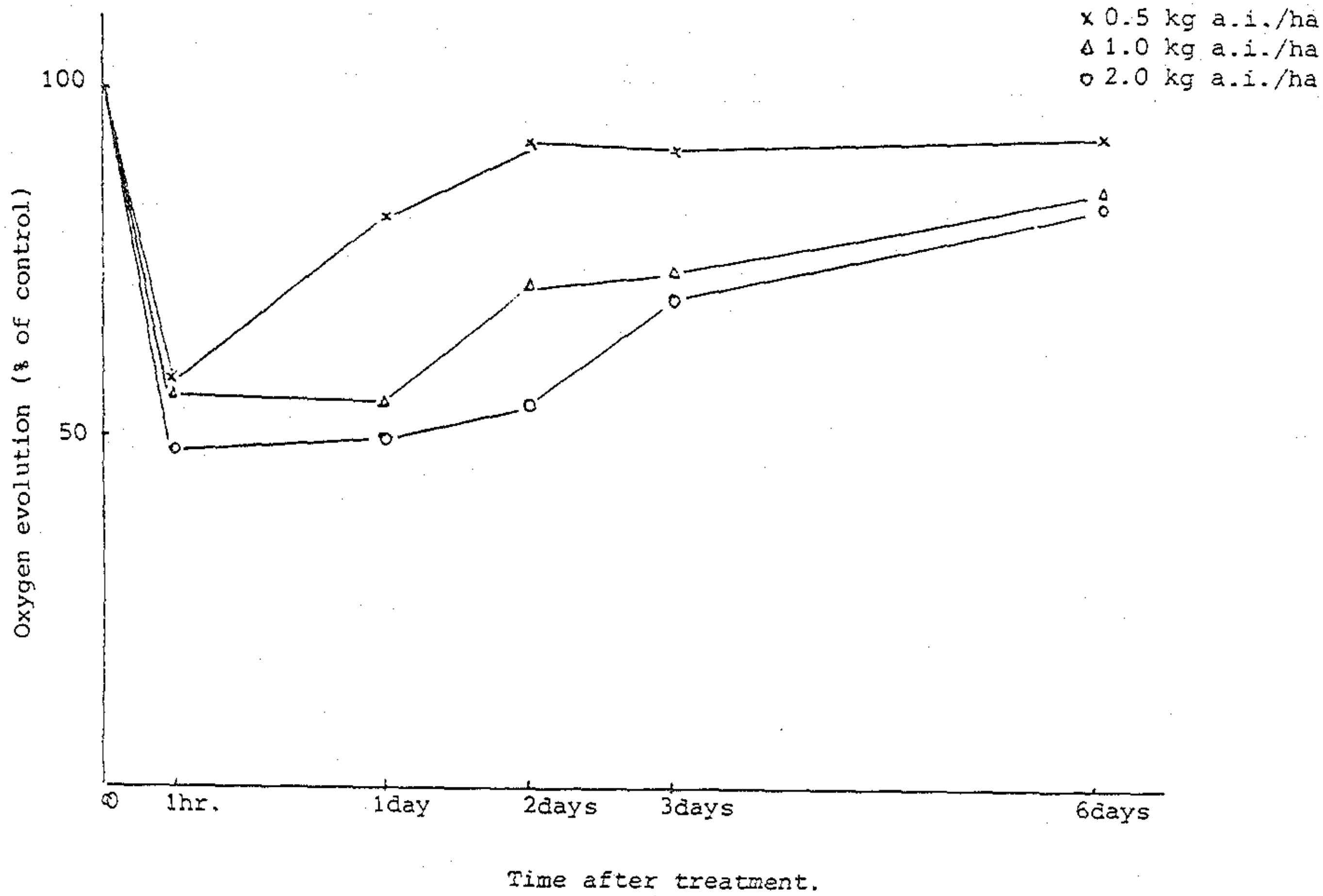

Figure IX-8. Effect of propanil on the Oxygen evolution of the leaves of Nihonbare.

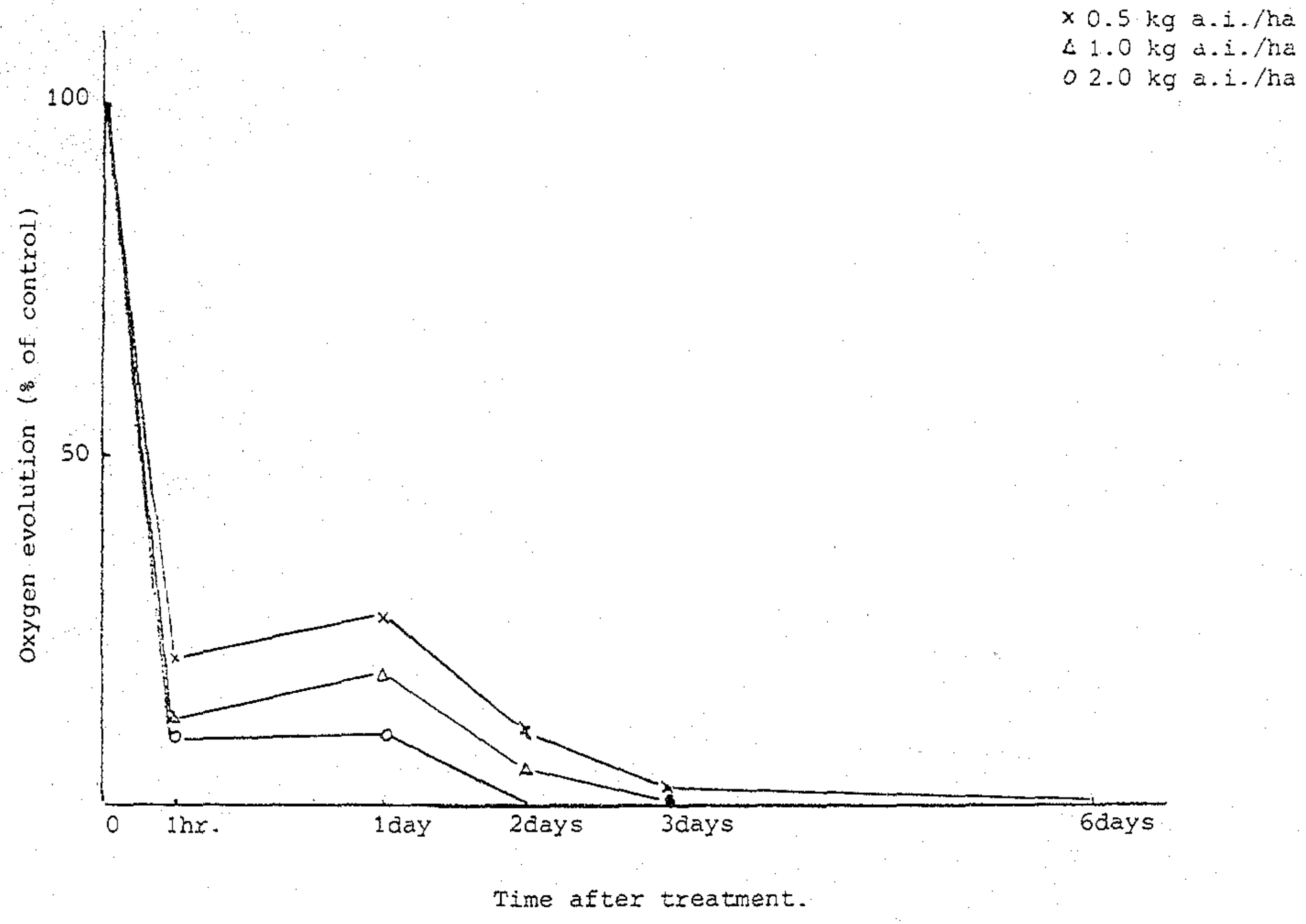

Figure IX-9. Effect of propanil on the Oxygen evolution of the leaves of <u>Echinochloa crusgalli</u>.

X. GENERAL DISCUSSION

Wild rice (Oryza perennis) was found to be distributed almost all Provinces of Thailand in our investigations. Types and habitats of wild rice were ranged differently from Province to Province, namely, an annual, a perennial and an intermediate perennial-annual continum(36), growing in deepwater paddy field, lowland paddy field, abondoned field, roadside canal or ditch, marsh, swamp and lake.

The most hazardous aspect of wild rice is its infestations into direct sowing paddy fields. These weedy types of wild rice which grow in paddy field, compete with cultivated rice for light, nutrients, and space, thus reducing yields of cultivated rice, lowers the grade of rice due to the presence of red grains(9), cause a natural hybridization with cultivated rice. Weedy type of wild rice was observed in Nakhon Nayok, Prachin Buri, Ayutthaya, Sing Buri, Nakhon Si Thammarat and Songkhla. In the worst cases, farmers would have to abondon a tillage of their fields.

The seed of wild rice shatters readily, and has seed dormancy, enabling survival for extended periods under unfavourable conditions(9). Under tropical condition, seed dormancy in wild rice would be broken through a dry and high temperature regimes, which processes were proved in our experiment. Wild rice start to germinate at almost same time with direct sown cultivated rice. Their growth rate was at the same pace, but heading date of weedy types of wild rice were earlier than that of cultivated rice. However, heading time of the weedy types of wild rice were generally extended longer, thus offering an overlapping period with cultivated rice and cause natural hybridization. Hybrid swarms are increasing year by year.

Regeneration from stem segment or ratoons were extremely rapid in a perennial type of wild rice.

Within our experiment on chemical control of wild rice, no herbicides were highly selective between cultivated and wild rice. Among them,although benthiocarb with NA exhibited a good result in pot test, a field test will be required for practical use.

Further studies on yield loss of cultivated rice due to the competition with wild rice, a comparative dry matter production, life cycle of an annual and perennial type of wild rice should be continued to elucidate the ecological aspects of wild rice.

XI. SOME SUGGESTIONS FOR CONTROL OF WILD RICE

It is rather difficult to selectively control wild and cultivated rice by chemicals since both rice plants belong to the same genus or species. However, method for control of wild rice will be divided into two ways, that is, cultural control and chemical control.

1. Cultural control of wild rice

From our experiment,the emergence of wild rice from deep soil layer was lower than that of cultivated rice. Therefore, infestation of wild rice is rather low in transplanted or pre-germinated rice field, where plowing, hallowing, and puddling are practiced thoroughly.

The present recommendations for control are :(1) use of clean, uncontaminated seed,(2) pre-germinated seeding or transplanting after plowing and puddling,(3) Pulling out wild rice seedling at initial stage, (4) Selecting short season rice varieties, (5) Burning of stubble during dry season, (6) Crop rotation.

2. Chemical control

Herbicides tested in our research were not highly selective between cultivated and wild rice. Benthiocarb with NA as pre-emergence herbicide, showed an efficacy against wild rice species but not to the extent to put into a practical use. Spraying with paraquat or glyphosate before plowing (34) could be used for control of wild rice seedlings emerged in a ratoon crop.

Future considerations

Weedy types of wild rice are a serious problems in direct-sowing rice areas in Thailand. The controls are laborious and expensive, and either cultural or chemical control method can not be effective in these areas. Therefore, a combination of these methods are required.

The research results reported in this paper is limited and further studies shoud be intensified. Pertinent factors affecting wild rice problems in direct-sowing areas should be taken into consideration. The factors required consideration include :

* conjecture the occurrence of wild rice in advance,
* Practice plowing operations,
* Renew cultivated rice seeds at regular intervals,
* Investigate on integrated control methods.

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XIII PLATES

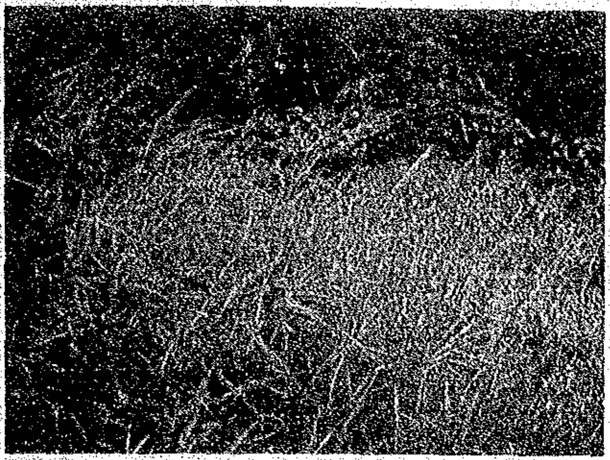

Plate 1. A perennial type of O. perennis growing in a roadside canal, Lomsak, Phitsanulok (Aug. 10, 1982)

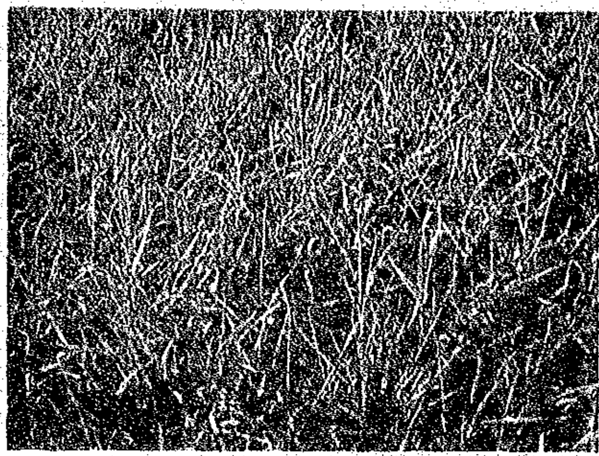

Plate 2. A perennial type of O. perennis growing in a roadside canal, Phrankrotai, Sukhothai (Nov. 26, 1981)

Plate 3. A hybrid type wild rice (front) growing in a swamp near Wangyai, Nakhon Phanom (Sept. 1, 1982)

Plate 4. An annual type of O. perennis growing in a roadside canal at Ban Maka, Buri Ram (Aug. 31, 1982)

Plate 5. A perennial type of O. perennis growing, partly grazed, in a lake at Bandonchan-Bang, Sakon Nakhon (Sept. 2, 1982)

Plate 6. An annual type of O. perennis growing in a roadside canal at road mark 2.2, near Sakon Nakhon Airport, Sakon-Nakhon (Sept. 2, 1982)

Plate 7. Weedy type of wild rice growing in a rice field near Chai Nat Dam, Chai Nat (Dec. 9, 1982)

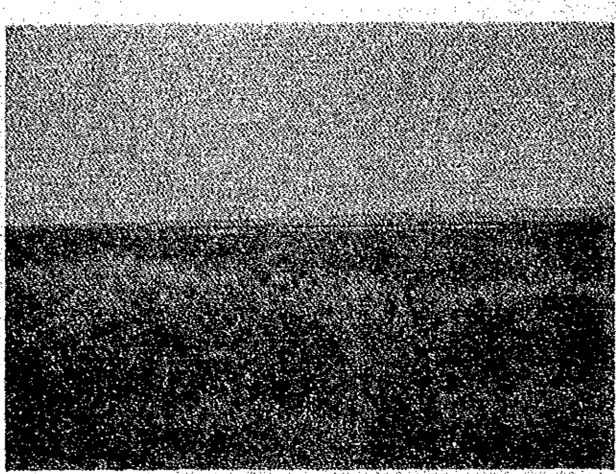

Plate 8. A weedy type of wild rice growing in a deepwater rice field at Ongkharak, Nakhon Nayok (Oct. 8, 1981)

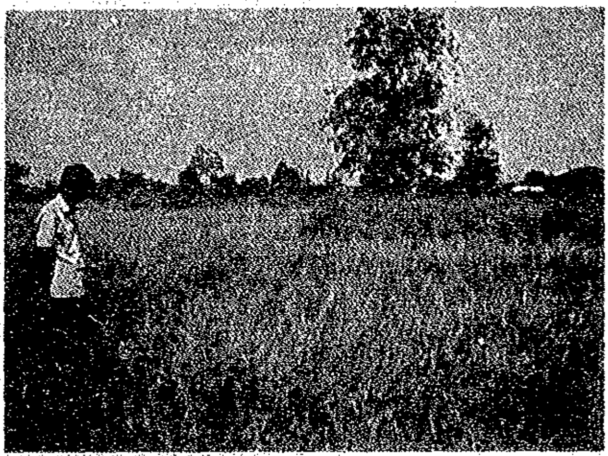

Plate 9. Habitat segregation between the annual type of O. perennis (front) growing in an abandoned field and cultivated rice (back) in Saraburi (Oct. 7, 1982)

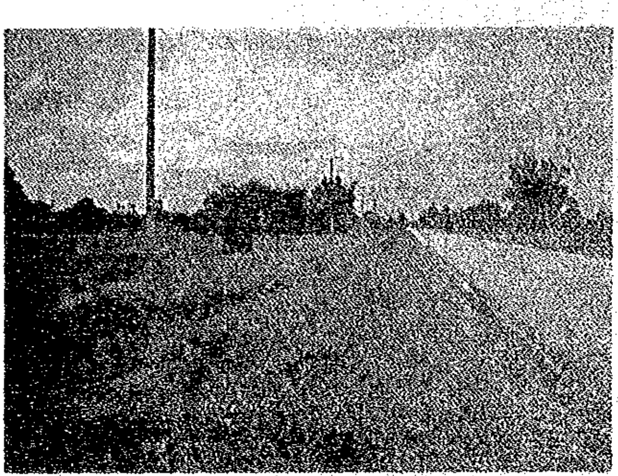

Plate 10. An annual type of O. perennis growing in a roadside ditch at Tarang, Saraburi (Oct. 13, 1983)

Plate 11. Weedy wild rice growing in a deepwater rice field at Bankayai, Ayutthaya (Dec. 9, 1982)

Plate 12. Ratoon of weedy type wild rice growing under dry deepwater rice field at road mark 125, Sing-Buri (June. 17, 1982)

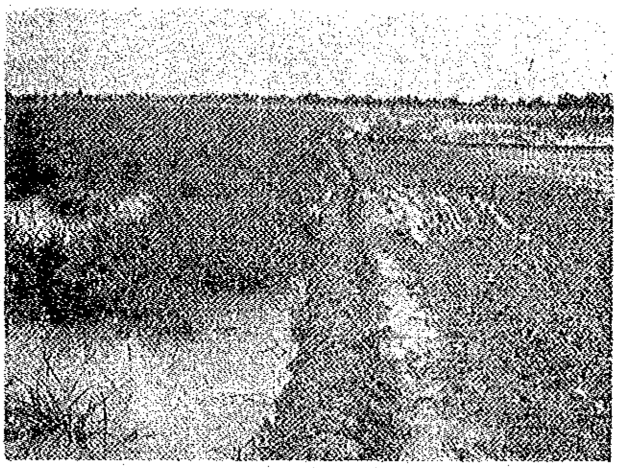

Plate 13. A weedy type of wild rice regenerated from rhizome in a deepwater rice field at roadmark 125, Sing Buri (July. 12, 1983)

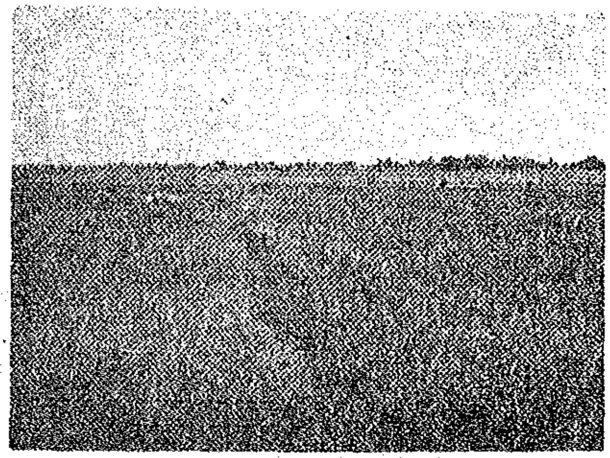

Plate 14. A perennial-annual intermediate type of weedy wild rice in a deepwater rice field at road mark 125, Sing Buri (December 21, 1983)

Plate 15. An annual type of weedy wild rice growing in lowland rice field at Chianyai, Nakhon Si Thammarat (March 3, 1983)

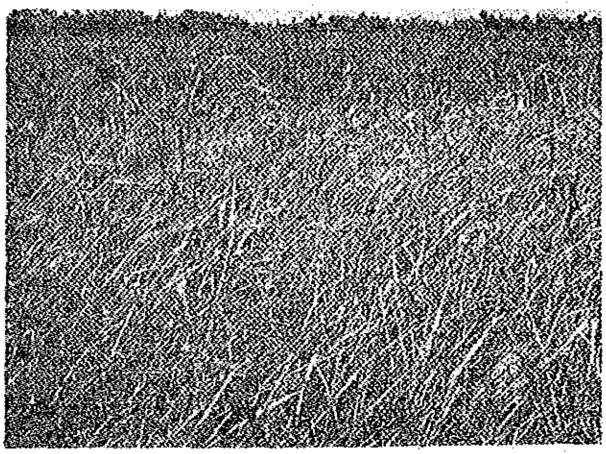

Plate 16. An annual type of weedy wild rice growing in a lowland rice field at Muang, Nakhon Si Thammarat (March 3, 1983)

Plate 17. Weedy type of wild rice growing in a lowland rice field at Ranot, Songkhla (March 3, 1983)

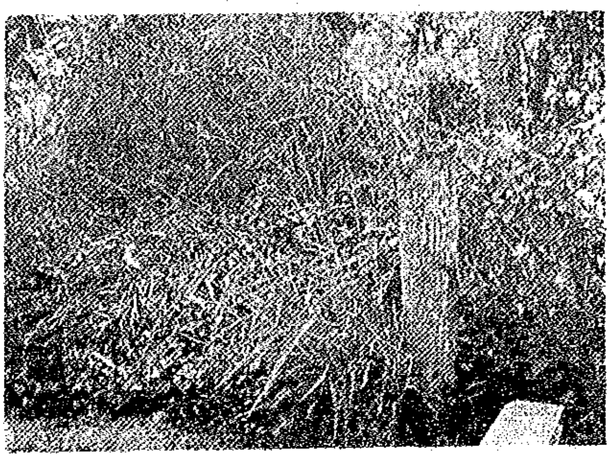

Plate 18. O. officinalis growing in a durian orchard at Bangkoknoi, Bangkok (Nov. 24, 1983)

Plate 19. A wild rice seedling (left) growing at the same growth rate with direct-seeded cultivated rice in deepwater rice field at Ongkharak, Nakhon Nayok (June 3, 1982)

Plate 20. Weedy type of wild rice growing in a rice field near Chai Nat Dam, Chai Nat (Dec. 9, 1982)

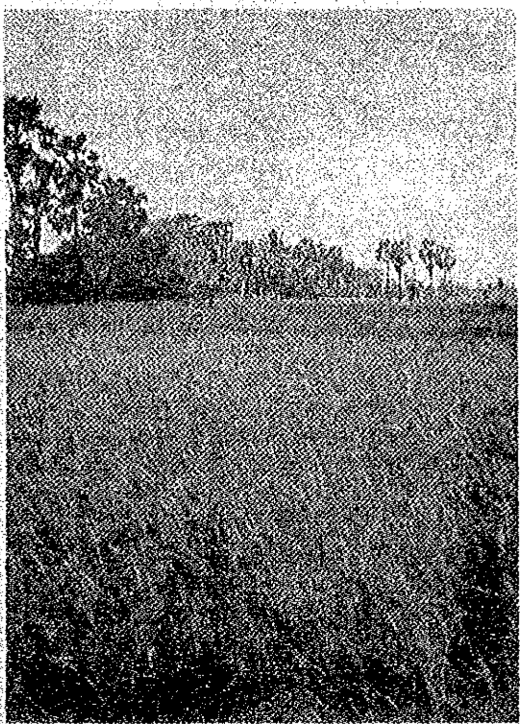

Plate 21. A weedy wild rice (front) growing in lowland paddy field at Ranot, Songkhla (Jan. 20, 1982)

Plate 22. A perennial type of O. perennis growing in a deep canal at Bangkoknoi (Dec. 28, 1983)

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