RESULTS

The diagram of the productive structure of the Waterhyacinth population is shown in Table II-1 and Fig. II-1.

Standing crop, the ratio of the above-ground section to the under-ground section and the ratio of the above-water section to the under-water section of this population were 1.17 kg d.w./m^2, 1.53 and 0.62, respectively.

The C/F value (the ratio of non-photosynthetic organs. To photosynthetic organs in the above-ground section) of this population was 1.92. The photosynthetic organs was found to be distributed in the following percentages, 4.5%, 47.1%, 34.7%, 9.4% and 4.3%, in the following height layers 85-65 cm, 65-45 cm, 45-25 cm, 25-5 cm and 5--15 cm, respectively. The non-photosynthetic organs was found to be distributed in the following percentages 2.2%, 15.7%, 29.9% and 52.2%, in the following height layers 65-45 cm, 45-25 cm, 25-5 cm and 5--15 cm, respectively. The value of relative light intensity was decreased largely among the upper part of the population, and reached less than 1% from the 30 to the 10 cm height layers.

The ratio of vertical distribution between the decayed section and the living section in the above-ground section is shown in Table II-2. The decayed section of blades was found not only in the lower part but also in the upper part of this population. The ratio of blades showed 0.22-0.32 above 25 cm height, but showed 1.0 below 25 cm height. The ratio of petioles showed 0-0.07 above 25 cm height, but 0.11-0.17 below 25 cm height.

The leaf area in each height layer of this population is estimated from the weight of the blades using SLA value (230 cm^2/d.w.g). The leaf area index of this population was 5.5 m^2/m^2, calculated from the above-mentioned table.

DISCUSSION

The diagram of the productive structure of the Waterhyacinth population corresponds with the "herb type" of a terrestrial plant population by Monsi and Saeki (1953), as pointed out by Osada and Okiwo (1986). The main productive part of this population lies in the 85-25 cm layer, namely the upper 60% of population height, judging from the vertical distribution of the relative light intensity, living foliage and decayed foliage. The dry matter of the foliage in this part showed 86.3% of total foliage and its leaf area is estimated at 4.9 m^2/m^2 (Table II-3).

Table II-1. The productive structure of the Waterhyacinth (<u>Eichhornia</u> <u>crassipus</u> (Mart.) Solms) population, gained at the pond in Bangkok, Thailand, Feburary, 1986. This population was at 100 cm height from the petiole base. The figure in parentheses shows the height of the measuring point of relative light intensity.

height above water surface	blades		petioles		No. of	roots	stoloe	relative light	
	alive	decayed	alive	decayed	petioles			intensity	
cm	$d.w.g/m^2$	$d.w.g/m^2$	$d.w.g/m^2$	$d.w.g/m^2$	$No./m^2$	$d.w.g/m^2$	$d.w.g/m^2$	%	(cm)
85 — 65	10.99	2.46	-	-				100	(85)
								60	(70)
65 — 45	113.57	29.44	10.35	-	67			13	(60)
								8.9	(50)
45 — 25	83.27	26.53	72.87	5.10	214			2.3	(40)
								0.92	(30)
25 — 5	22.72	23.22	138.65	23.84	245			0.68	(20)
								0.80	(10)
5 — -15	10.42	10.73	241.98	26.60				-	-
Total	240.97	92.38	463.85	55.54		406.12	54.20		

Table II-2. The ratio of dacayed part to living part in each layer of Waterhyacinth (Eichhornia crassipes (mart.) Solms) population, being gained from ca. 100 cm height population at the pond in Bangkok, February, 1986.

Population height from water surface (cm)	blades	petiole
85 - 65	0.22	-
65 - 45	0.26	0
45 - 25	0.32	0.07
25 - 5	1.02	0.17
5 - -15	1.03	0.11

Table II-3. The vertical distribution of blades in Waterhyacinth (Eichhornia crassipes (Mart.) Solms) population, gained at the pond in Bangkok, Thailand, February 1986. Blades area is estimated from the weight of blades using SLA value (230 cm^2/d.w.g). The figure in parentheses shows the percentage of each layer to the whole blades.

height above water surface cm	the weight of blades d.w.g/m^2	blades area cm^2/m^2	(%)
85 - 65	10.99	2500	(4.5)
65 - 45	113.57	26100	(47.1)
45 - 25	83.27	19200	(34.7)
25 - 5	22.72	5200	(9.4)
5 - -15	10.42	2400	(4.3)

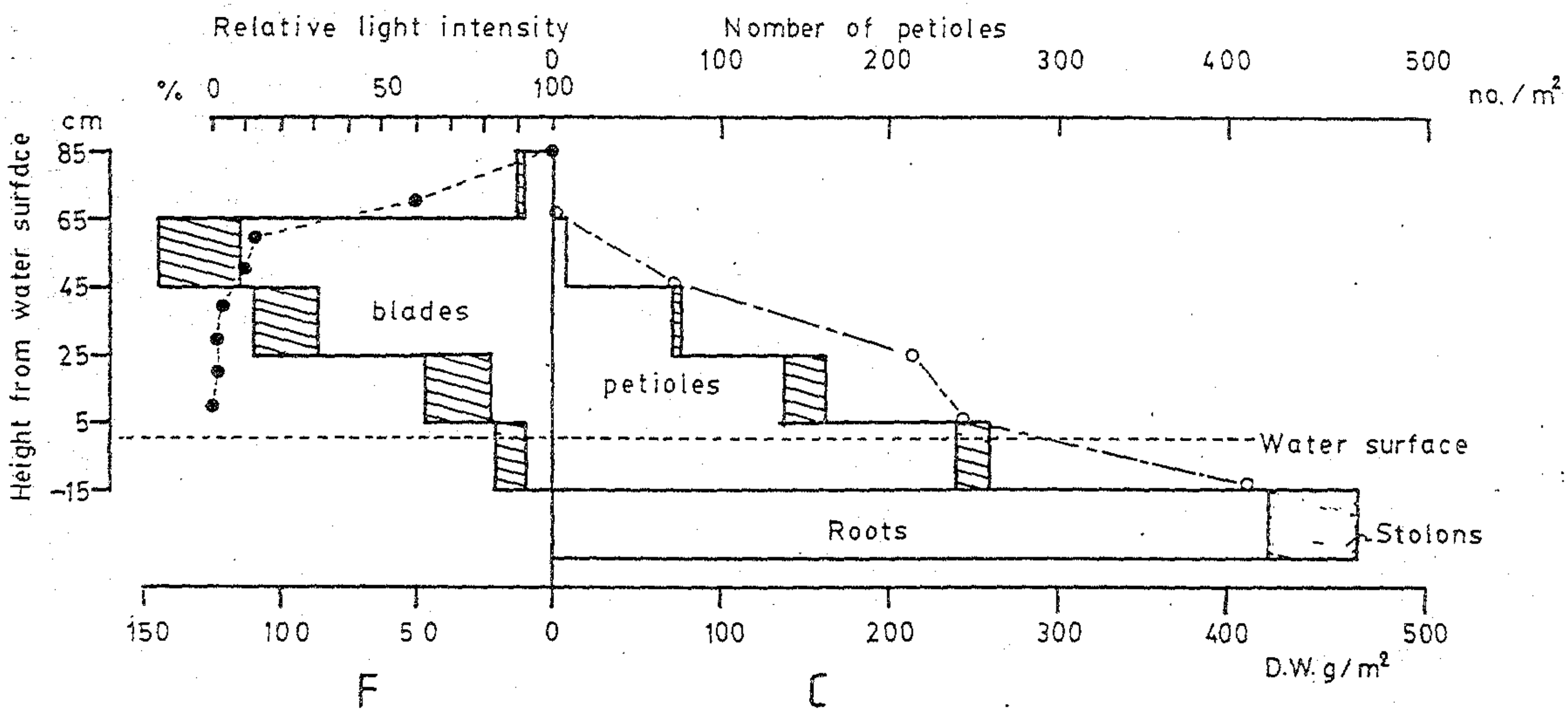

Fig. II-1. The diagram of the productive structure of the Waterhyainth (*Eichhornia crassipes* (Mart.) Solms), gained at the pond in Bangkok, Thailand, Feburary, 1986. The height, standing crop and leaf area index of this population are 100 cm, 1.17 d.w.dg/m^2 and 5.5 m^2/m^2, respectively. The 62% of the standing crop of this population sank under water-surface. ▨ indicates the decayed part of each organ.

III. THE BIOMASS AND SOME CHARACTERISTIC OF THE WATERHYACINTH (*EICHHORNIA CRASSIPES* (MART.) SOLMS) POPULATIONS WHICH GROW IN NATURAL CONDITION.

INTRODUCTION

It is important for the actual handling of the Waterhyacinth population for its cultivation, use and control to know the biomass and their characteristics. Some Waterhyacinth populations grow under natural condition were investigated for this purpose in Thailand. The characteristics of a population, in this report, means the population height, the number and size of constituent plants, the leaf area index and the distribution of biomass in each organ, etc....

METHOD

The collection of Waterhyacinth was carried out in a monospecific stand of uniform height. Three quadrats with 50 x 50 cm^2 was set in that stand, and all plants were harvested within each quadrat.

The sample from a quadrat is divided into several units of which each is composed of a larger mother stocks and a few smaller stocks still connected by stolons. This unit is named an "individual" in this report. At first, the number of each component such as individuals within a quadrat, daughter stocks of an individual, and leaves of a stock was counted. Maximum leaf height of an individual was measured, being regarded as individual height. A stock was cut into blades, petioles, roots, stolons, and decayed part. These organs were drought with the dry oven at 80°C until their weight reached at constant weight, and were weighed respectively. Standing crop of a population was calculated from these values. In harvesting, several blades were collected at the same stand. The area and dry weight of each blade were measured, from which Specific Leaf Area (SLA) was calculated. Leaf Area Index (LAI) of a population was estimated, base on SLA and total dry weight of blades in a population.

In some Waterhyacinth stands, an organ was measured in fresh weight instead of dry weight. Dry weight of an organ was estimated from DW/FW ratio which was determined in the Chapter I.

RESULTS AND DISCUSSION

The biomass and some characteristics of the Waterhyacinth popuoations which grow under natural conditions in different habitats are shown in Tabel III-1.

These results about population height, the number of individuals ~~popu-~~ (population density) and biomass are compared with chose of other reports. The relationship between the height and the biomass of the Waterhyacinth populations which grew in different places under natural condition is shown in Fig. III-1. The coefficient of correlation among these population was 0.571. But the relationship between the height and the density of these populations indicated clearly an inverse relation.

Table III-1. The biomass and some characteristics of the Waterhyacinth (*Eichhornia crassipes* (Mart.) Solms) populations which grow under natural conditions.

* The value of decayed part was indicated in fresh weight g/m^2

** The figure in parentheses was the specific leaf area (cm^2/d.w.g) of plants of each size used for estimating the value of LAI

Location	Bangkhen I (creek)	Bangkhen II (creek)	Bangkok (pond)	Uthai Thani (pond)
Date	13/12/85	17/12/85	12/12/85	23/07/86
Height (cm)	60	85	111	111
Biomass (d.w.g/m^2)	1020	1400	983	2230
Decayed part (d.w.g/m^2)	56.0	42.8	53.6	(2530*)
The number of plants				
Mother (No./m^2)	36	48	9.2	24
Daugther (No./m^2)	49	20	23	32
The number of shoots (No./m^2)	520	480	220	524
Distribution ratio				
Blades (%)	25.4	24.6	18.8	9.5
Petioles (%)	48.4	60.8	56.4	48.5
Roots and Stolons (%)	26.2	14.7	25.8	42.0
Leaf area index (m^2/m^2)	6.7	9.3	4.2	4.9
	(260)**	(270)**	(230)**	(230)**

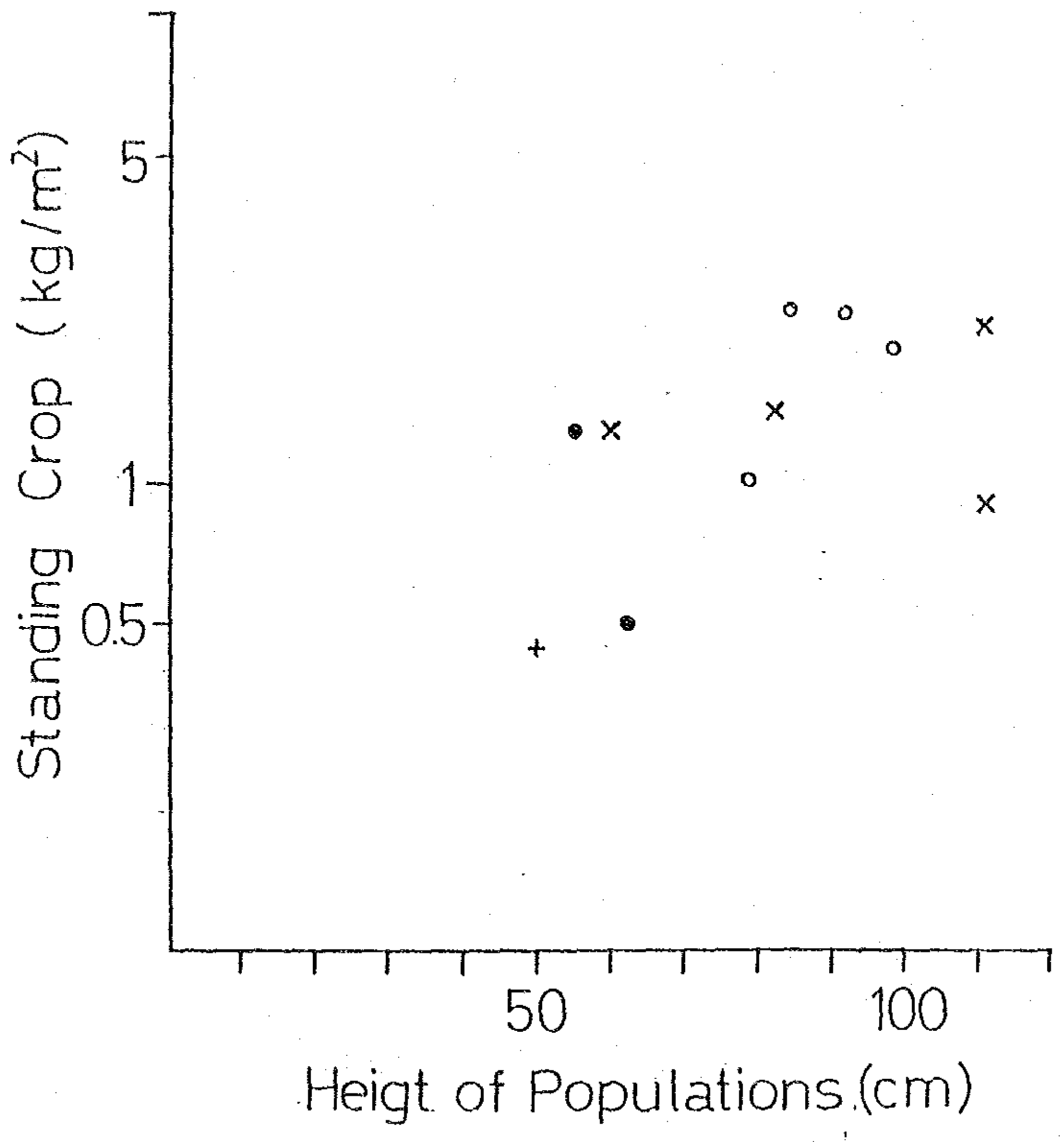

Fig. III-1. The relationship between the height and biomass of the Waterhyacinth (Eichhornia crassipes (Mart.) Solms) populations which grow under natural condition in different places. x, o, ● and + mean the value of this study, Osada and Okino (1986), Shibayama (1980), Ueki (1977) and Sato's Kondo (1981), respectively.

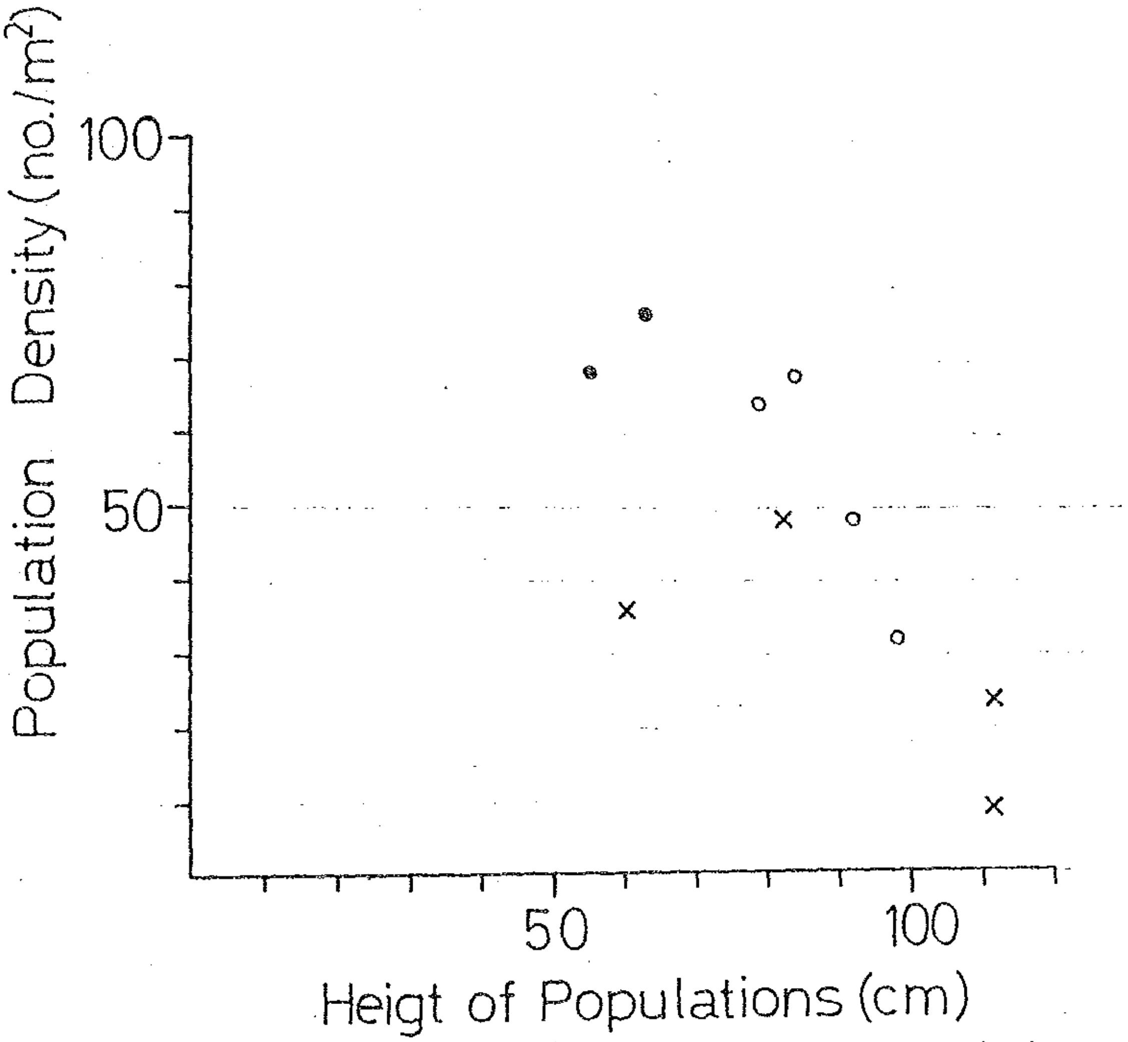

Fig. III-2. The relationship between the height and the population density of the Waterhyacinth (Eichhornia crassipes (Mart.) Solms) populations which grow under natural condition in different places. x, o and ● neam the value of this study, Osada and Okino (1986) and Shibayama (1980), Ueki (1977), respectively.

参考 2

JUNE 14, 1986

SURVEY OF HERBICIDE RESIDUES IN CORN FIELD SOILS AT PAK CHONG

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Preface

It is now closing 68 days of my stay in Thailand as a short-term expert of NWSRI Project by JICA. Assisted by many Thai colleagues and Japanese experts, I could carry out my duty to advice on herbicide residue studies. The schedules and the research works are herein presented.

On this occasion, I would like to express my thanks to Dr. Yookti Sarikaphuti : Director-General of Department of Agriculture, Dr. Riksh Syamanonda : the Deputy Director-General, Dr. Tanongchit Wongsiri : the Deputy Director-General, Dr. Umpol Senanarong : the Deputy Director-General, and Mr. Visut Chandrangsu : Director of Botany and Weed Science Division, for much arrangements to me.

I am very grateful to Dr. Paitoon Kittipong : Chief of Weed Science Group and all researchers of the group for their kind hospitalities. I also express my sincere thanks to Dr. Kenji Noda : the leader of NWSRI Project, Dr. Jiro Harada, Mr. Teruhiko Nibe, and Mr. Masao Osada : the experts of NWSRI Project, and secretariates of NWSRI Project for their useful advices and assistances.

June 13, 1986

TADAO YAMADA

Main Schdules During Stay in Thailand

April 8	Arrival to Bangkok
April 9 - June 13	Study works on Survey of Herbicide Residues in Corn Field Soils at Pak Chong
April 16	First visit to National Corn and Sorghum Research Center (Pak Chong in Nakhorn Ratchasima Province)
April 23-28	Attendance to Seminar of Department of Agriculture
May 6-9	Attendance to the 2nd Meeting of Weed Science Society of Thailand (Chantaburi Province), and presentation to it of a paper entitled Some Problems on Herbicide in Japan.
May 21	Second visit to National Corn and Sorghum Research Center
May 29-30	Visits to Agricultural Development Research Center, Khon Kaen Field Crop Research Center, and Khon Kaen University (Khon Kaen Province)
June 6	Presentation to Special Seminar, Problems on Herbicide Use by Dr. Tadao Yamada, held by Weed Science Society of Thailand (Kasetsart University, Bangkhen)
June 11	Presentation to NWSRI Seminar
June 14	Leaving Bangkok

Survey of Herbicides in Corn Field Soils at Pak Chong

Tadao Yamada, Prateep Krasaesindhu,

Chanya Maneechote and Khempetch Chaiyamart

I. Introduction

A triazine herbicide, atrazine has been internationally wide used for weed control in corn fields. Our motives of this study were the appeals of agronomists that, owing to persistence of atrazine in soil, wheat does not grow well after the croppings of corn in the fields of National Corn and Sorghum Research Center at Pak Chong, Nakhorn Ratchasima. We tried to determine the contents of atrazine in soils which was suspected to carryover it.

Our experiments included the determination of another herbicides, alachlor and butachlor in soils, and were extended to soils from several fields different in growth stages of corn. The results of these chemical analyses made clear the status of residues of these herbicides in soils under the conditions at Pak Chong as shown here.

II. Methods and Materials

(1) Soil sampling

Soil samples were taken from the fields F-12, E-9, F-5 and F-9 of National Corn and Sorghum Research Center at Pak Chong on April 16 and May 21, in 1986. The field F-12 which was appealed on sufferings of wheat, was sampled soils from 5 layers different in depth (0-50 cm), at three replicates different in sampling sites. The history of herbicide applications to F-12 is shown in Table 1. Soil samplings from corn fields E-9, F-5 and F-9 were carried out at 2 replicates different in sampling sites, as shown in Table 2. Samples were about 1 kg each in size, put into plastic bags and kept in refrigerator until analysis. Soil characters of the Pak Chong soil are as follows : pH (H_2O) 6.8, organic matter 2.42%, sand 17%, silt 39%, clay 44%, soil texture clay and CEC 15.3 me/100g. Mean temperature (1951-1980) in Nakhorn Ratchasima Province was 26.4^{o}C. Water supply to the field F-5 was estimated as 595.2 mm of rainfall during 75 days as shown in Table 3.

(2) Determination by Gas Chromatography

The conditions for gas chromatography of three herbicides as shown in Table 4. The peaks of herbicides are sharp and proportional to the amount of injected herbicides as shown in Fig. 1. The herbicides in soils were extracted and cleaned up by the method shown in Fig. 2. The recoveries of herbicides fortified to soil are shown in Table 5. The detectable limits of herbicides (ppm per dry soil) were atrazine : 0.001, alachlor : 0.003 and butachlor : 0.005 as the extracts were adjusted to 1.5 ml.

III. Results and Discussions

(1) Herbicide Residues in Soils from the Field F-12

As shown in Table 6, atrazine was not detected more than 0.001 ppm in all soils. The detections of atrazine near to the detectable limit were not clearly different from the contaminants in the analytical process. Butachlor applied 6 months ago for the cropping of wheat, was detected only 0.02 ppm in top soils, and not detected in soils from lower layers. Alachlor was not detected at all.

From the result, the cause of growth inbition of wheat in the field F-12 has to be sought for another except the residue of atrazine in soil.

(2) Persistence of Atrazine in Soils from Corn Fields

As shown in Table 7, atrazine was detected at higher levels from E-9, at moderate levels from F-5, and at lower levels from F-9. These data are plotted on a semi-legarithm section paper as shown in Fig. 3. The dotted line shows a recurring straight line which represents a half-life of 19 days on atrazine in soils from 0-10 cm depth. That is the atrazine conventionally applied to corn fields decreases rather rapidly to about 1% during 4 months under the conditions at Pak Chong. Leaching of atrazine was not approved significantly.

Buchanan et al. (1973) reported that a half-life of atrazine obtained by an bioassay was 20 days in corn fields in Alabama. Literatures on carryover of atrazine are not available here so much, and then I will later refer to literatures in detail. Alachlor and butachlor were not detected at all.

IV. Acknowledgement

We appreciate Mr. Porn Rungchaeng : Director of National Corn and Sorghum Research Center, Mr. Thamrongsil Pothisoong and Mr. Pipat Verathavorn for their kind cooperations to take soil samples. And also we are grateful to Professor Umporn Suwanamek for his encouragements.

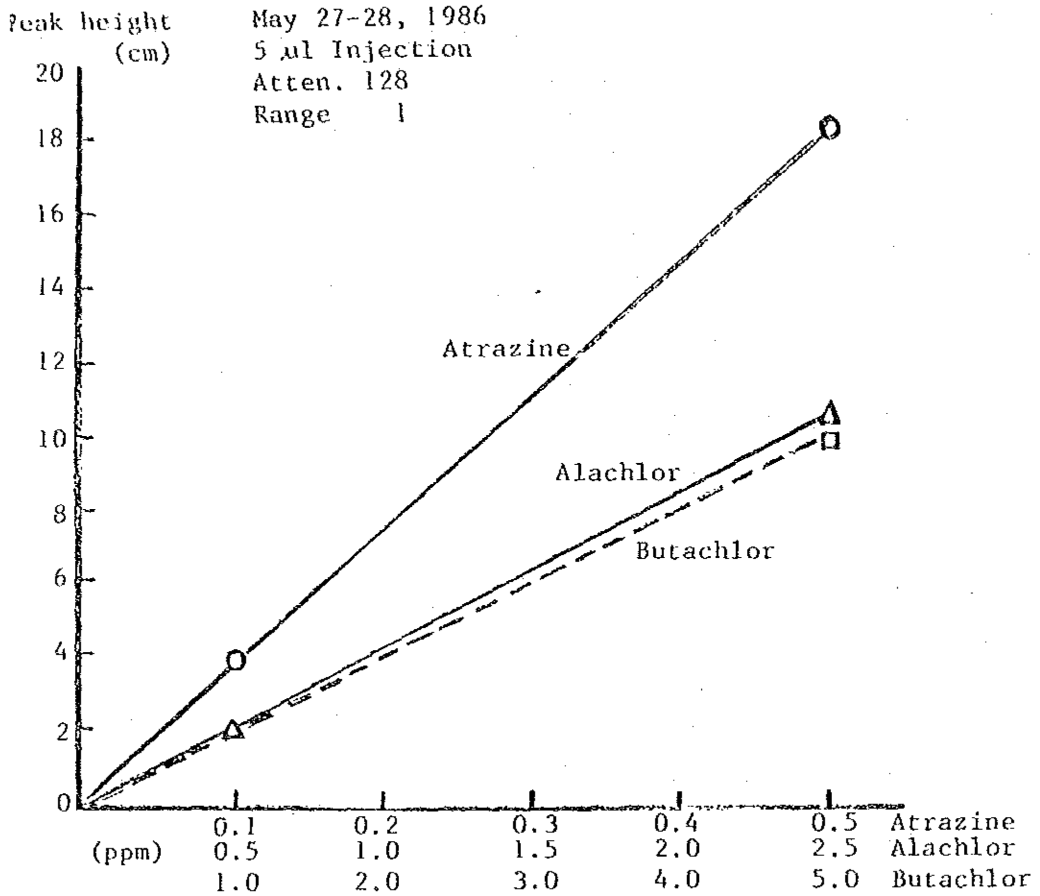

Fig. 1. Calibration Curves of Atrazine, Alachlor and Butachlor

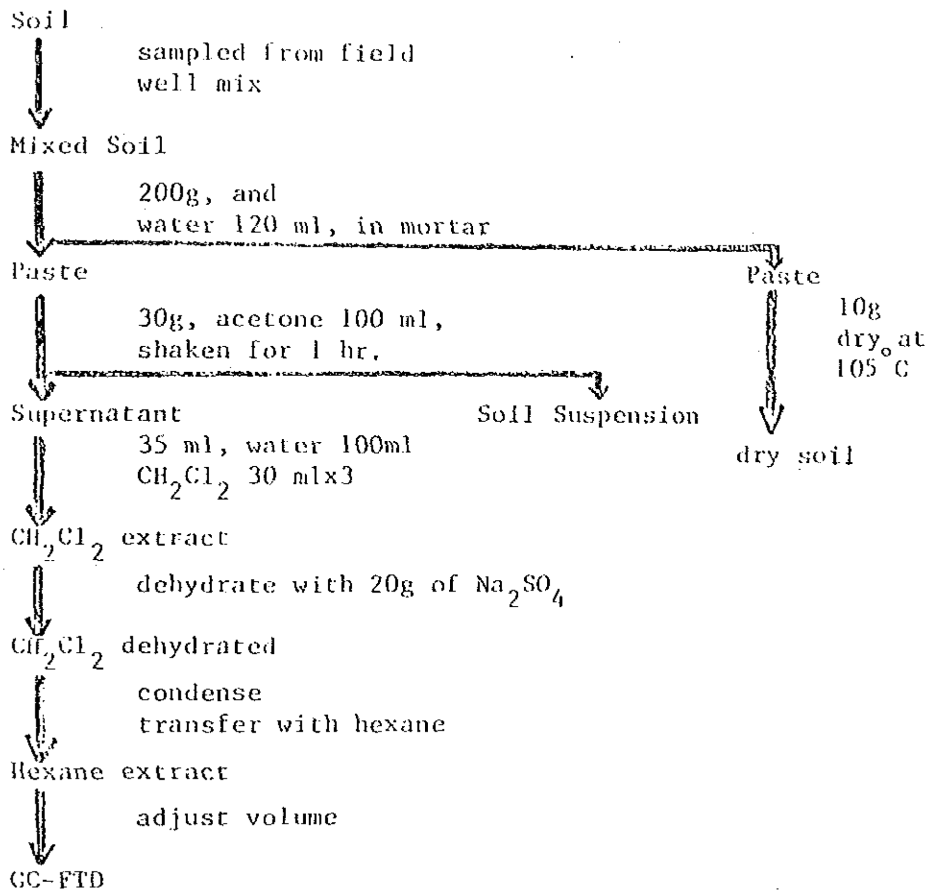

Fig. 2. Flow Diagram of Extraction of Atrazine, Alachlor and Butachlor from Soil

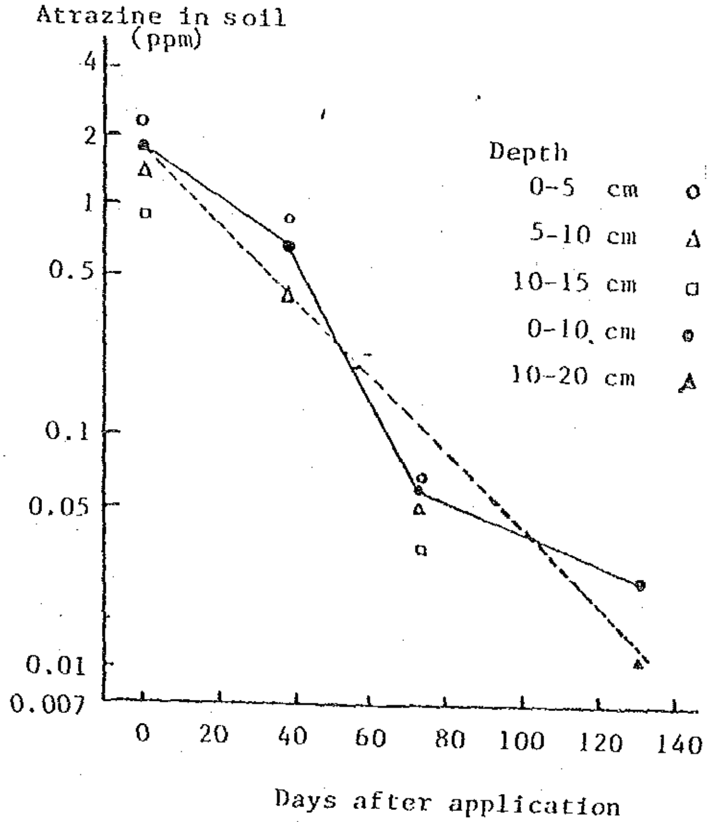

Fig.3. Persistence of Atrazine in Corn Field Soils.

Table 1. Herbicide Applications to the Field F-12 and Soil Sampling

Year	Crop	Herbicide*
-1979	corn, 2 croppings/year	atrazine 3.8 kg
1980-1984	wheat, seeded in Oct.	butachlor 1.9 kg 2,4-D, 2.5 kg glyphosate (1983,1984)
1985	corn, seeded in Mar.	
	wheat, seeded in Oct.	butachlor 1.9 kg 2,4-D, 2.5 kg
1986		soil sampling on Apr.16

* ai/ha to each cropping

Table 2. Soil sampling from corn fields

Field	Corn seeded	Atrazine* application	Soil sampling			State of corn
			date	days	depth(cm)	
E-9	May 19	May 21	May 21	0 (ca. 1 hr)	0- 5 5-10 10-15	pre-emer.
F-5	Mar. 6	Mar. 9	Apr.16	36	0- 5 5-10	seedling (20-30 cm)
			May 21	73	0- 5 5-10 10-15	ripening
F-9	Jan. 8	Jan. 10	May 21	131	0-10 10-20 20-30 30-40 40-50	harvesting

*Gesaprim (80% WP) 750 g/rai = atrazine 3.75 kg/ha

Table 3. Water Supply to the Corn Field F-5

March	Water supply	April	Water supply	May	Water supply
8	Sp	4	Ra 0.4 mm	1	Ra 16.0 mm
13	Sp	5	Ra 29.0	2	Ra 2.2
16	Sp	6	Ra 4.0	4	Ra 14.3
20	Sp	7	Ra 0.2	5	Ra 49.1
25	Sp	9	Sp	6	Ra 4.7
28	Ra 2.5 mm	12	Ra 1.4	7	Ra 1.3
	Total 202.5	13	Ra 15.4	8	Ra 6.3
		15	Ra 2.0	9	Ra 13.0
6	Seeded	18	Fu	10	Ra 16.0
9	Atrazine application	21	Ra 1.4	13	Ra 2.7
		23	Fu	15	Ra 0.5
		24	Ra 7.8	19	Fu
		25	Ra 1.1	21	Ra 12.8
		26	Ra 2.4		Total 178.9
		27	Ra 22.5		
		28	Ra 0.7		
		30	Ra 5.5		
			Total 213.8		

8 March - 21 May (75 days) = 595.2 mm
Sp : Sprinkling equivalent to 40 mm rainfall
Fu : Furrow irrigation
Ra : Fainfall

Table 4. Gas Chromatography

Shimadzu GC-7AG (FTD)	
Column	: glass 1.1m x 3.2mm, packed with 5% DC-200 on Chromosorb WAW DMCS, 80-100 mesh
Temp. (^{o}C)	: oven 220, injection 260
Gas (ml/min)	: N_2 50, H_2 3.5, air 150
Range x Atten.	: 1 x 128
Chart (mm/min)	: 10
Rt (min)	: atrazine 0.81 alachlor 1.24 butachlor 2.41

Table 5. Recoveries of Atrazine, Alachlor and Butachlor from Soil

Herbicides	Fortification*		Recoveries	
	ug	ppm**	ug	%
atrazine	0.2	0.013	0.16	82
	1.0	0.063	0.99	99
	1.0	0.065	0.94	94
alachlor	5.0	0.33	4.9	97
butachlor	2.0	0.13	1.9	94
	10.0	0.63	9.9	99
	10.0	0.65	9.2	92

* Soil paste 30g
** per dry soil

Table 6. Residues of atrazine and Butachlor in Soils from the Field F-12

Soil depth (cm)	Residues (ppm/dry soil)							
	atrazine				butachlor			
	I	II	III	av.	I	II	III	av.
0 - 10	t	t	t	t	0.02	0.02	0.02	0.02
10 - 20	t	t	t	t	n	n	n	n
20 - 30	t		0.001	t	n		n	n
30 - 40	t				n			
40 - 50	t				n			

t : trace (0.001), n : non-detectable (0.004)

Table 7. Residues of Atrazine and Butachlor in Corn Field Soils at Pak Chong in Relation to Depths.

Field	Depths (cm)	Atrazine (ppm/dry soil)	Butachlor (ppm/dry soil)
E-9 (0 DAA)	0-5	2.154	n
	5-10	1.403	n
	10-15	0.923	n
F-5 (38 DAA)	0-5	0.870	n
	5-10	0.420	n
F-5 (73 DAA)	0-5	0.069	n
	5-10	0.048	n
	10-15	0.032	n
F-9 (131 DAA)	0-10	0.024	n
	10-20	0.011	n
	20-30	0.003	n
	30-40	0.003	n
	40-50	0.004	n

DAA : Days after the latest application of atrazine
n : Lower than 0.004 ppm

参考 3

HERBICIDE-PLANT HORMONE INTERACTIONS IN RICE PLANT

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NOVEMBER 7, 1986

Preface

I had a second chance to stay in Department of Agriculture, Bangkok, Thailand as a short-term expert of NWSRI Project supported by JICA. My main objectives in NWSRI Project were the cooperative research performance using something new equipments for plant physiological approaches suppled by JICA with the staffs of Botany and Weed Science Division.

A part of our research works in progress are herein presented.

Let me take this opportunity of thanks to Dr. Yookti Sarikaphuti (Director-General of DOA), Dr. Riksh Syamanonda (Deputy Director-General), Dr. Tanongchit Wongsiri (Deputy Director-General), Dr. Umpol Senanarong (Deputy Director-General) and Mr. Visut Chandrangsu (Director of Botany and Weed Science Division) for the fruitful arrangement to me.

I'd like to express my thanks to Dr. Paitoon Kittipong (Chief of Weed Science Group) and the all researchers for their heartful hospitalities.

I am also grateful to Dr. Kenji Noda (NWSRI Project Leader), Dr. Jiro Harada, Mr. Teruhiko Nibe and Mr. Masao Osada (Project Experty) and secretaries for their useful advice and assistance.

November 7, 1986

Hitoshi SAKA

Herbicide-Plant Hormone Interaction in Rice Plant

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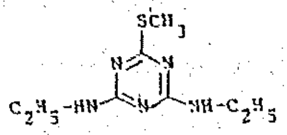
I. Introduction

Simetryn (Table 1) which inhibits the photosynthesis by blocking the photosystem II action was usually used for paddy weed control (10-15 days after transplanting of rice) as a mixture with benthiocarb (Trade name : Saturn-S) or molinate (Trade name : Mametto).

Generally speaking, Simetryn is liable to cause some chemical injury to transplanted rice seedling at high temperature condition (Sago et al., 1981). Indica type rice variety is more sensitive than Japonica (Ito et al., unpublished). At the other hand, rice plant (even Indica type) is resistant to dimethametryn (Table 1) which belong to the same group (s-triazine herbicides) as simetryn (Ito et al., unpublished). Moreover, Brassinolide, one of new plant growth regulators (Table 1) represents the protective effect against the chemical injury by the some herbicides, such as simetryn, molinate, benthiocarb and pretilachlor as a safner (Hamada et al., 1985).

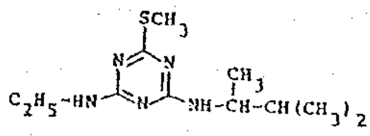
In this experiment, we studied on Simetryn-Brassinolide interaction in the rice growth based on some experimental phenomena mentioned above. The experiment was performed in Department of Agriculture, Bangkhen, Bangkok, October 1986.



simetryn

Mol. wt. : 213.3

2,4-bis (ethylamino)-6-methylthio-1,3,5-triazine



dimethametryn

Mol. wt. : 255.4

2-(1,2-dimethylpropylamino)-4-ethylamino-6-methylthio-1,3,5-triazine

brassinolide

Mol. wt. : 608.1

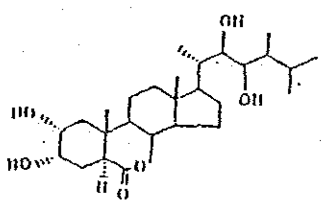


Table 1 . Chemical structure of s-triazine herbicides & brassinolide

II. Materials and Methods

Indica (var. RD-23, RD-25, Kao dok Mali) and Japonica (Nipponbare) rice was used for this experiment.

(1) Thirty to fourty day old rice seedlings were transplanted to 1/5000 a pot with fertilizer. Simetryn (Trade name : ghybon, 1.5% granular formulation. Ciba-Geigy Inc.) and dimethametryn (pure compound. Ciba-Geigy Inc.) are treated in water surface 7 days after transplanting.

(2) Thirty day old rice seedling (var. RD-23 and Nipponbare) was washed soil out from root and dipped in brassinolide (100 ppm Et-OH solution. Nissan Chemical Co. Ltd.) solution one overnight. After that, the seedlings were transplanted in pot to make grow for 7 days. Then, simetryn treatment was performed to investigate the effect of brassinolide action.

(3) In order to investigate the effect of simetryn and dimethametryn, and the simetryn - brassinolide interaction to the growing rice plants, some equipments, oxygen electrode system (Rank Brothers Inc., England), Infrared CO_2 gas analysis system (Horiba Inc., Japan), Porometer (Li.CO. Inc., U.S.A.), ATP Photometer (SAI Inc., U.S.A.) and double beam spectrophotometer (Shimazu Inc., Japan) were used. Temperature ($^{\circ}C$) in glasshouse was 24 - 26$^{\circ}C$ at minimum, and 32 - 40 $^{\circ}C$ at maximum per day.

Ⅲ Results and Discussions

I Experimental Survey of Plant Activity by Using some Equipment

(1) Porometric Diffusion Resistance (S/cm^{-1}) & Transpiration ($mg.cm^{2}.s^{-1}$)

Steady state Porometer (LI-1600, LI-COR Inc., U.S.A.) was used for the transpiration rate and diffusion resistance of intact rice leaf blade (Fig.2) grown in pot in glasshouse located in Department of Agriculture, Bangkhen, Bangkok. This handy-typed equipment could measure transpiration rate and diffusion resistance very easily dependent on its manuals without trouble. The result showed in Table 2. Almost same leaf samples in each pot were used for experiment. RD-25 represented the highest transpiration rates and lowest diffusion resistances, independent on day time for measuring. It is suggested that RD-25 may have a high photosynthetic activity.

(2) ATP Content in Intact Plant Leaf

ATP photometer (Model 2000, SAI Inc., U.S.A.) was used for intact leaf ATP content analysis. ATP extract from the intact leaf by boiling water method made reaction with luciferin-luciferase (FLE - 50, Sigma) assay system, and then detacted ATP content in the leaf by ATP photometer mentioned below :

*: 3 mm diameter
**: 50 mM Hepes-NaOH pH7.2

5 discs*/2.5ml buffer**
↓
heat treatment in the boiling water for just 1 min
↓
cooling at 3°C for 5 h., mild shaking
↓ (ATP extract)
Luciferin-Luciferase (FLE-50, Sigma)*** assay system
↓
ATP photometer

for calibration :
crystal ATP 1.0 ng/ml
(buffered) 0.1 ng/ml
0.04 ng/ml

***: fill up to 15 ml with 15 mM $MgSO_4$ solution and stand at 4°C for 2h.

Table 2. Varietal Differences of Transpiration Rate in Growing Rice Plants

Measurement	Variety	Diff. Resis. ($S.cm^{-1}$)	Trans. ($\mu g.cm^{2}.S^{-1}$)	Leaf. temp. (°C)	Cuvette temp. (°C)	Relative humidity (%)	Quantum ($\mu E.m^{2}.sec^{-1}$)
A.M. 10.30	RD-25	1.42	13.73	33.5	33.6	18.8	1050
Oct. 9	Kao dok Mali	2.18	10.11				
	Nipponbare	2.58	10.40				
P.M. 4.00	RD-25	1.29	18.3	32.0	34.4	22.0	600
Oct. 10	Kao dok Mali	3.68	8.34				
	Nipponbare	3.82	9.55				
A.M. 11.00	RD-25	0.93	19.83	28.9	31.2	27.6	850
Oct. 16	Kao dok Mali	1.75	12.25				
	Nipponbare	1.71	11.77				
	RD-25	1.21	17.29				
Mean	Kao dok Mali	2.54	10.31				
	Nipponbare	2.70	10.57				

Fully developed top leaf of main shoot were used for this experiment. 2-3 leaves per pot with 3 replication.

Table 3. ATP content in intact rice plant leaves

Number of leaf discs (ϕ3.0 mm)	ATP calculated from calibration
5	0.015 mg/2.5 ml
10	0.06
15	0.1
20	0.135

Leaf discs were prepared from the fully developed top leaf in rice (RD-25). Just after preparation, these discs were put in boiling water for 1 min. to make ATP extract.

ATP photometer detected leaf ATP content by using 10-20 pieces of leaf discs for extraction (Table 3). But, this method was not accepted for our experiments.

(3) Oxygen Electrode and Infrared Gas Analyzer for Photosynthesis Measurement

Oxygen electrode system for the detection of photosynthetic oxygen evolution illustrated before (Saka and Chisaka, 1985) had a good work. At the other hand, Infrared gas analyzer had a sudden trouble in the latter half during stay.

II. Activity of simetryn and dimethametryn on the rice growth in pot

Effect of simetryn and dimethametryn on the growth of rice (RD-25) was confirmed by the measurement of transpiration rate (Fig. 1) and diffusion resistance first. Both of herbicides conspicuously increased the transpiration rate day by day until 4th day after chemical treatment and sharply decreased there after.

No difference between simetryn and dimethametryn on the transpiration activity in leaf was detected at 7th day. But photosynthesis and dry weight of plant at 7th day day had the clear difference between 2 chemicals (Table 4). Fig. 3. also represent the quite different plant growth dependent on chemicals and their concentration. Dimethametryn (0.6 mg/pot) had promotive effect to plant growth with root system including photosynthesis.

Twenty-one days after herbicide treatments, the plants were died by simetryn (0.6, 1.8 mg/pot) but not by dimethametryn (0.6 mg/pot)

Table 4. Effect of simetryn and dimethametryn on the photosynthesis and some growth parameters

rice plant (RD-25)

(7 days)

Simetryne* (g/10a)	Dimethametryn (g/10a)	Phtosynthesis (μmole $O_2/dm^2/hr$)	Plant height (cm)	Longest sheath height (cm)	Dry weight of plant (g/2 plant)			
					root	shoot	leaf	leaf area (cm^2)
0	0	516.5(100)	53	23.4	0.39(100)	0.973(100)	1.00(100)	324.86(100)
30	0	574.3(111.3)	54.7	23.7	0.33(84.5)	0.706(93.1)	0.95(95.7)	265.56(81.7)
90	0	27.9(5.2)	45.3	21.8	0.30(77.7)	0.69(70.9)	0.73(72.9)	126.34(60.4)
0	30	713.4(138.1)	53.5	22.3	0.47(121.8)	1.16(119.2)	1.29(129.5)	370.83(114.2)
0	90	410.2(79.4)	51.9	22.0	0.28(71.5)	0.59(60.6)	0.74(73.9)	233.67(71.9)

* Conversion into ghybon (1.5% simetryn granular formulation) gives 2 kg/10a & 6 kg/10a, respectively.

Experiments were performed seven days after herbicide treatments.

Table 5. Effect of Brassinolide on the rice growth

(17 days)

Variety	Brassinolide (ppm)	Photosynthesis (µmole $O_2/dm^2/hr$)	Trans (µg $cm^2.s^{-1}$)	Diff. Resis ($S.cm^{-1}$)	Chlorophyll (ng/gm^2)
RD 23	0	345.5(100)	20.31(100)	0.95(100)	
"	10^{-3}	341.9(98.9)	18.7(92.7)	1.1(116.2)	
"	10^{-2}	441.1(127.7)	21.2(105.3)	0.99(103.2)	
Nipponbare	0	515.4(100)	16.9(100)	1.38(100)	
"	10^{-3}	616.2(119.5)	16.3(96.2)	1.3(92.7)	
"	10^{-2}	617.6(119.8)	13.01(76.7)	1.7(125.4)	

After dlipping the part of root of rice into Brassinolide solution for one over night, rice seedlings (40 day old seedlings) were transplanted in pot in the glasshous.

(Fig. 4).

Effect of simetryn and dimethametryn to intact plant in pot, however, sometime fructuated dependent on each plant. Plant part such as root, shoot, leaf and leaf area were affected by chemicals at the same level (Table 4).

From the results mentioned above, it is conducted that simetryn has a stronger growth inhibiting effect to rice plant than dimethametryn although the appearance of inhibiting symptom by herbicide is late a little bit. Indica type (RD-25) is also sensitive to dimethametryn. It was also suggested that Indica type rice (RD-25) was sensitive not only to simetryn, but also to dimethametryn.

III. The protective effect of brassinolide against the growth inhibition by simetryn in rice.

Although brassinolide slightly increased by photosynthetic oxygen, evolution in 2 rice varieties, RD-23 and Nipponbare (Table 5). The plant growth with its transpiration is just inhibited by brassinolide (Table 6, 7). High concentration of brassinolide (10^{-2} ppm) is specially inhibitive for these growth porometers in both varieties (Table 7) different from their photosynthetic properties and from gross morphology showned in Fig. 7. Lower concentrations of brassinolide (10^{-4} ppm or less) should be tested at the vegetative growth stage.

At the other hand, it was suggested that brassinolide had the protective activity against the growth inhibitive action of simetryn at 10^{-2} ppm for Nipponbare (Table 7, Fig. 6). Brassinolide, however, accelerated its growth inhibition in RD-23 (Table 7, Fig. 5).

Although the transpiration rates fructuated dependent on the combination of chemicals, their properties confirmed the growth patterns affected by brassinolide and simetryn and their combinations (Table 5, 6 and Fig. 5, 6).

It is expected that repeatable experiment is necessary for the establishment and the elucidation of brassinolide and simetryn interaction in rice growth regulation.

Table 6. Simetryn-Brassinolide interaction on the transpiration in Rice (RD-23 and Nipponbare)

Variety	Simetryn (kg/ha)	Brassinolide (ppm) 0 Tr.	0 DR	10^{-3} Tr.	10^{-3} DR	10^{-2} Tr.	10^{-2} DR
RD-23	0	20.6(100)	0.97	20.8(100)	0.94	19.9(100)	1.14
	6	12.4(60.1)	2.30	2.3(11.05)	12.30	2.3(11.6)	7.90
Nipponbare	0	8.5(106)	1.98	7.1(100)	2.90	2.7(100)	0.24
	6	7.0(82.6)	2.7	4.5(63.4)	9.9	6.2(229.6)	0.28

(RD - 23 & Nipponbare)

(14 days)

Variety	Simetryn (Kg/ha)	Brassinolide (ppm) 0 root	shoot (g D.Wt./2 plants)	leaf	10^{-3} root	shoot (g D.Wt./2 plants)	leaf	10^{-2} root	shoot (g D.Wt./2 plants)	leaf
RD- 23	0	0.70(100)	2.39(100)	2.90(100)	0.43(100)	1.90(100)	2.40(100)	0.52(100)	1.90(100)	2.60(100)
	6	0.52(74.3)	0.95(41.3)	1.60(55.2)	0.43(100)	1.90(100)	2.60(108.3)	0.31(59.6)	0.58(30.5)	1.02(37.2
Nipponbare	0	0.61(100)	1.80(100)	1.80(100)	0.55(100)	1.60(100)	1.70(100)	0.24(100)	1.10(100)	1.20(100)
	6	0.21(34.4)	0.61(33.9)	0.61(33.9)	0.22(40.0)	0.72(45.0)	0.81(47.6)	0.28(117.0)	0.89(79.1)	0.94(78.3

Fourty day old seedlings were used the experiment. After dipping the root of seedling in Brassinolide solution for one over night, they transfered to make grow more in pot. Then water surface treatment of simetryn were performed to make grow more for 8 days.

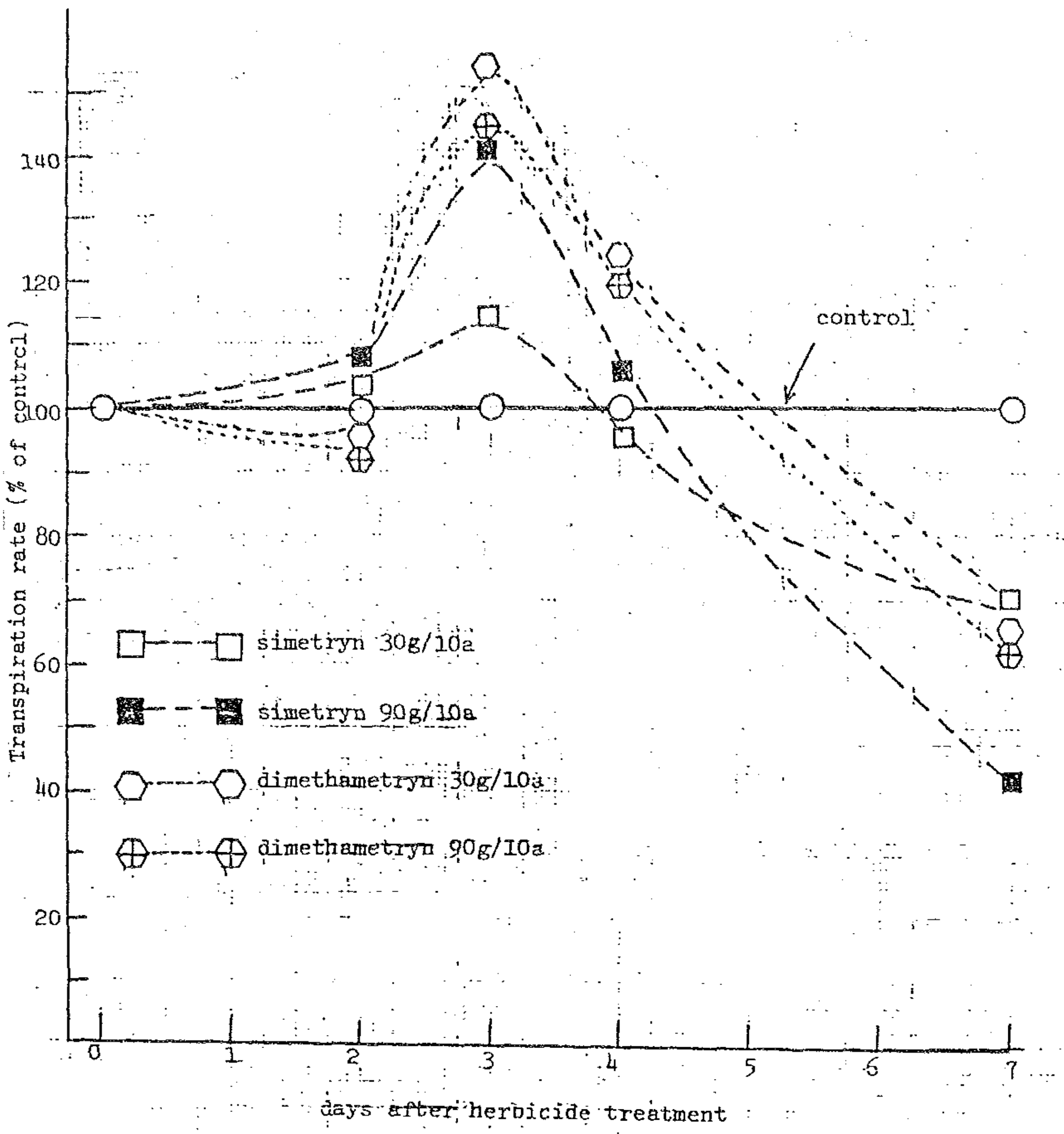
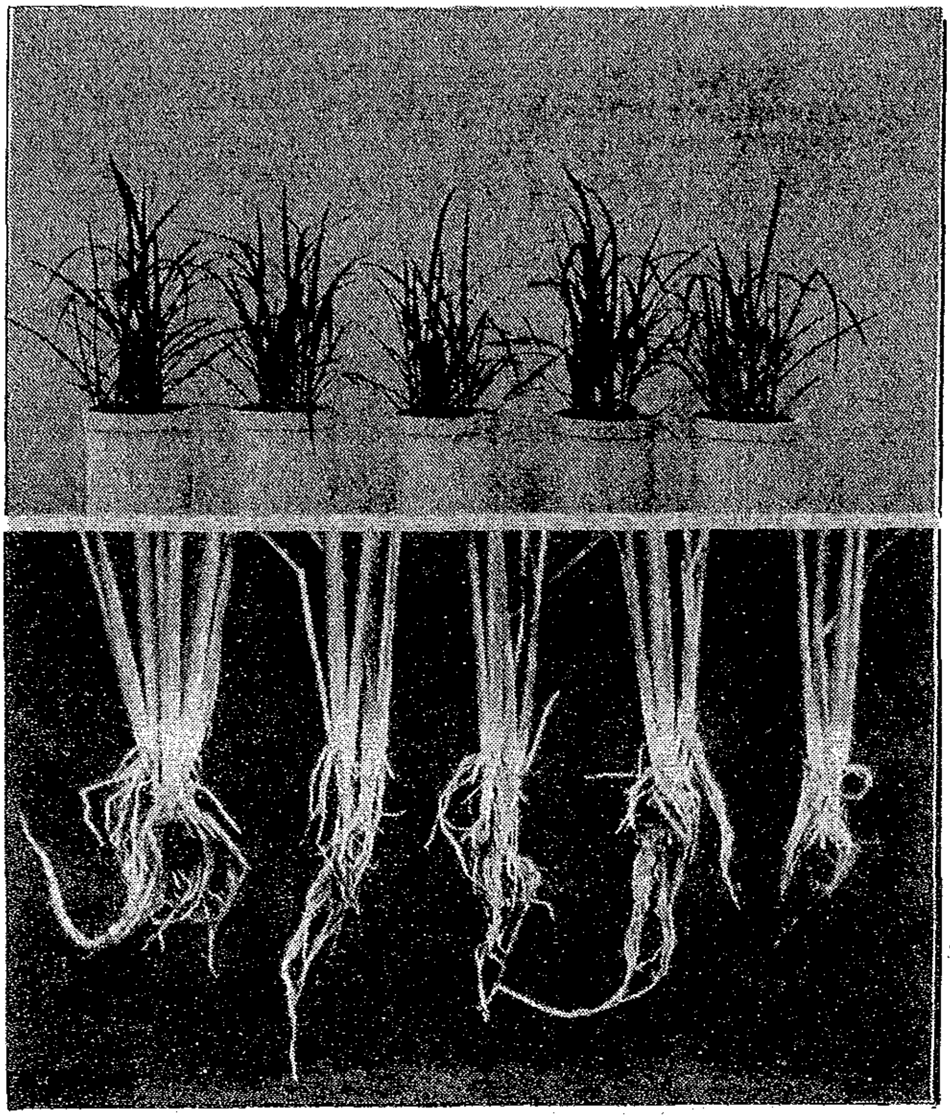


Fig. 1 . Time dependent changes of transpiration rate in rice (RD-25) treated by Simetryn.

Nipponbare (Japonica) | Kao Dok Mali (Indica) | RD-25 (Indica)

Fig. 2 . Rice varieties for measurement of super porometric transpiration & diffusion resistance.

Experiments were performed about 1.5 months growth stages after transplanting at 4th Sept., 1986. Nipponbare had already heading. Fully developed top leaf (flag leaf in Nipponbare) were used for measurement.

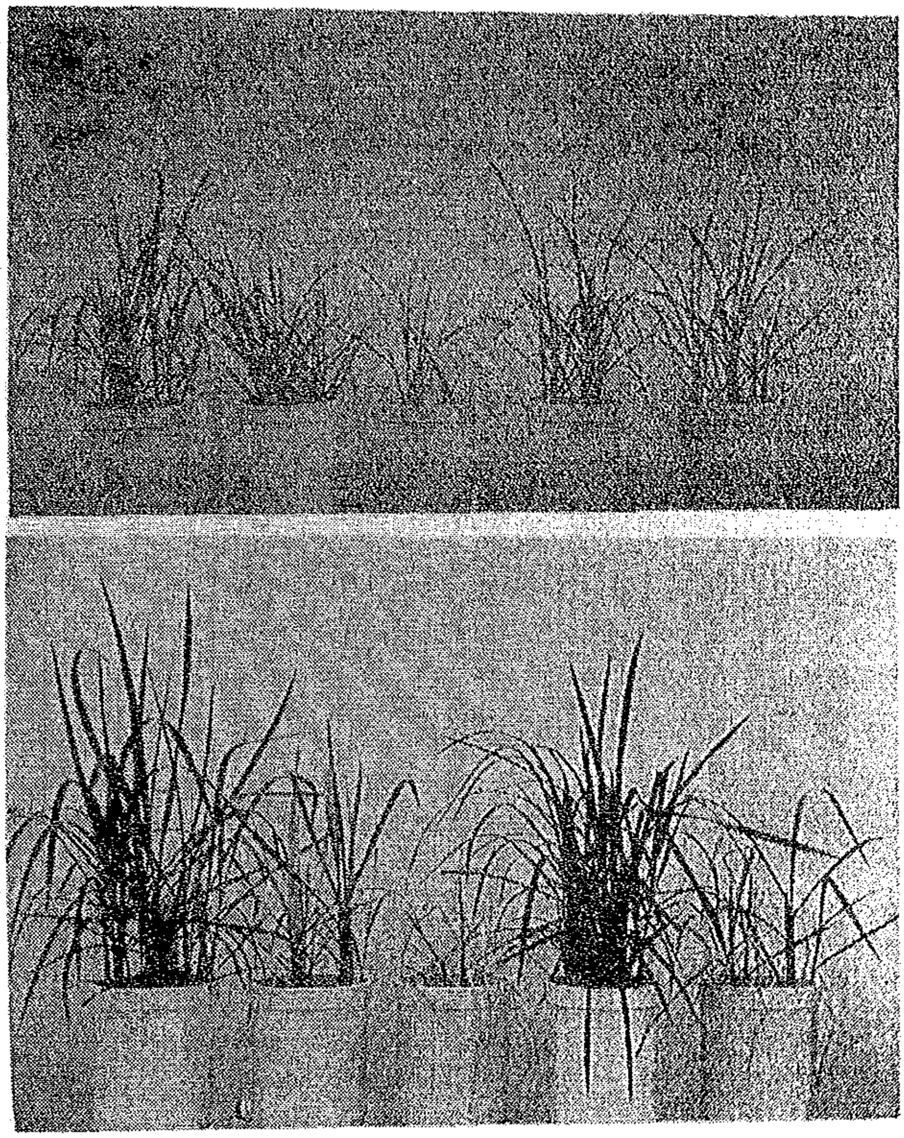


Simetryn	0	0.6*	1.8*	-	-
Dimethametryn	0	-	-	0.6*	1.8*

* mg active ingredient/pot (2.0 kg and 6.0 kg/ha, as a "glybon" granular formulation respectively).

Fig. 3 . Inhibitive effect of simetryn and dimethametryn on the Indica rice growth I (7 days after treatment).

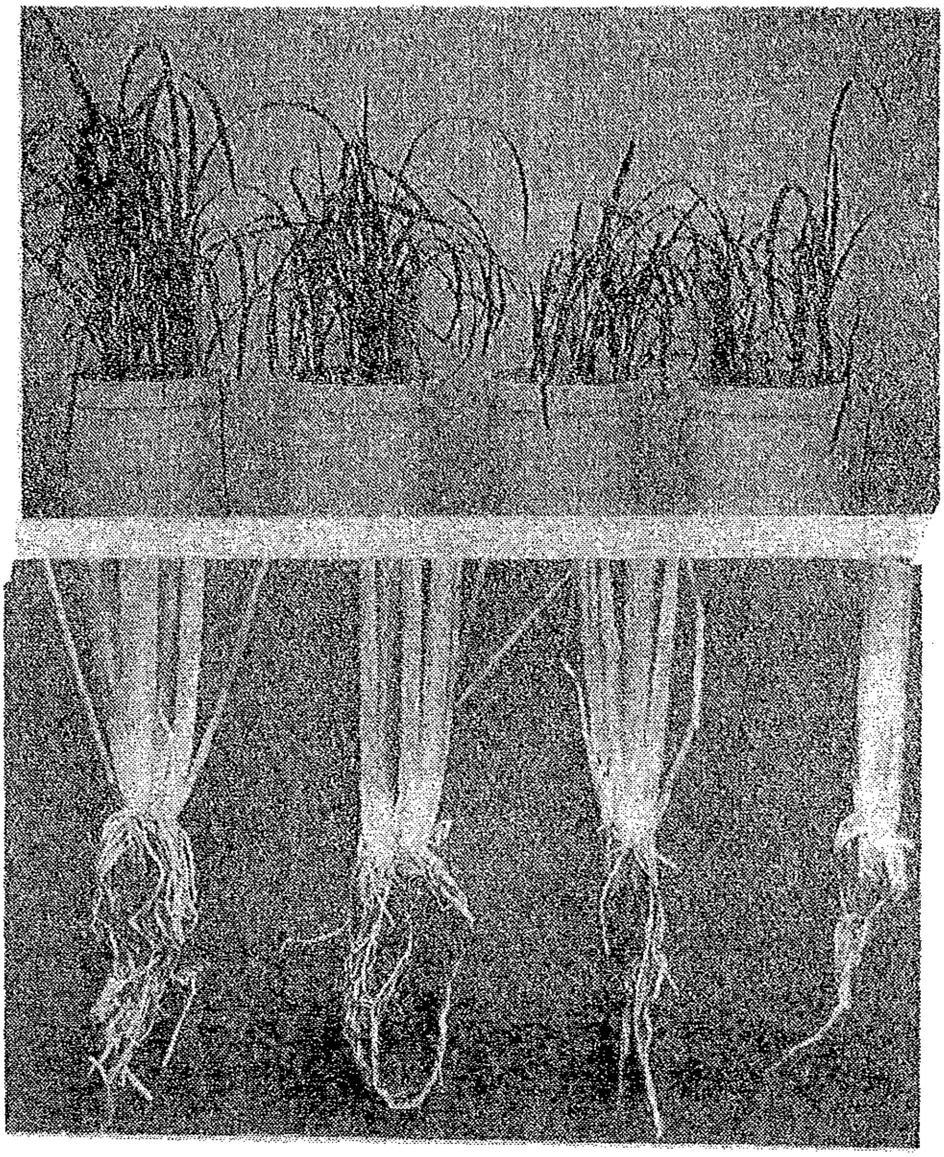
Root growth as well as short was affected by simetryn & high concentrations of dimethametryn.



Simetryn	0	0.6	1.8	-	-
Dimethametryn	0	-	-	0.6	1.8

* mg active ingredient/pot

Fig. 4 . Inhibitive effect of simetryn & dimethametryn on the Indica rice growth II (upper, 11 days), and III (lower, 21 days).
High concentration of demethametryn has also damage to Indica rice plant.



Simetryn*	0	6	6	6
Brassinolide**	0	0	10^{-3}	10^{-2}

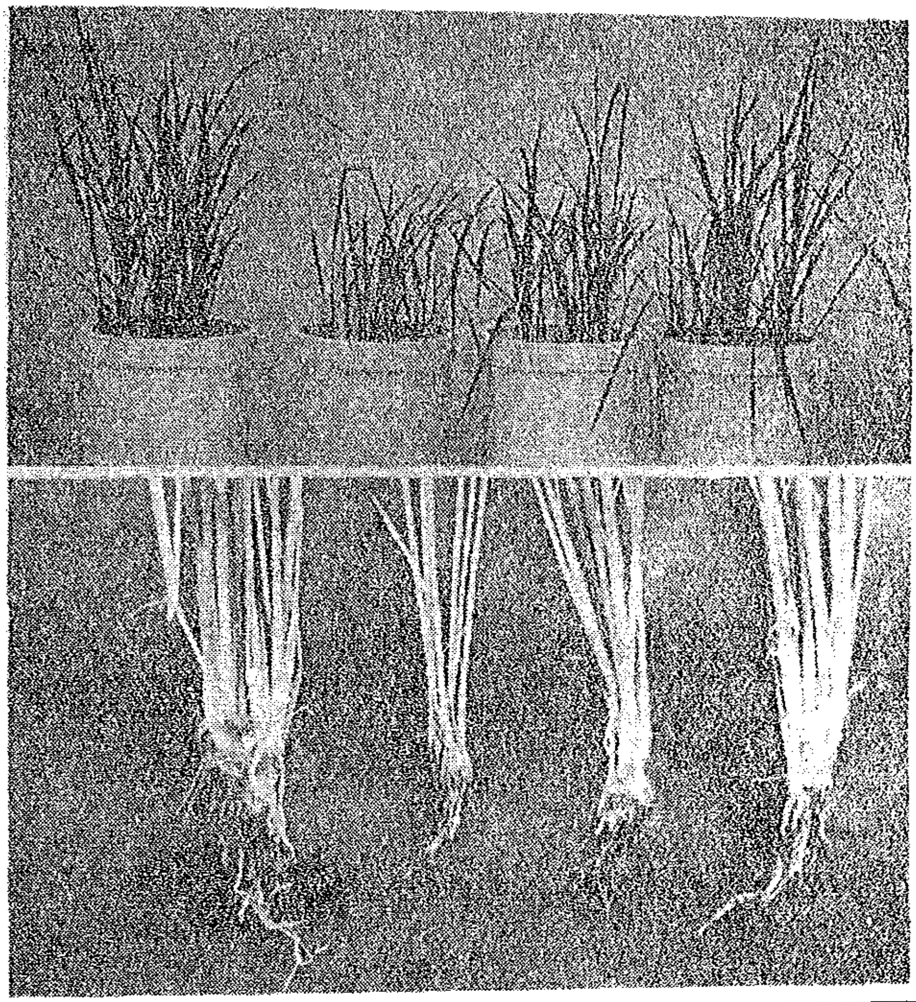
* : kg/ha as a granular formulation

** : ppm in H_2O

Fig. 5 . Simetryn - Brassinolide interaction for the growth in rice (Indica, RD-23).

Photographed 7 days after simetryn treatment in pot.

Fourty-day old seedlings were used for this experiment.



Simetryn*	0	6	6	6
Brassinolide**	0	0	10^{-3}	10^{-2}

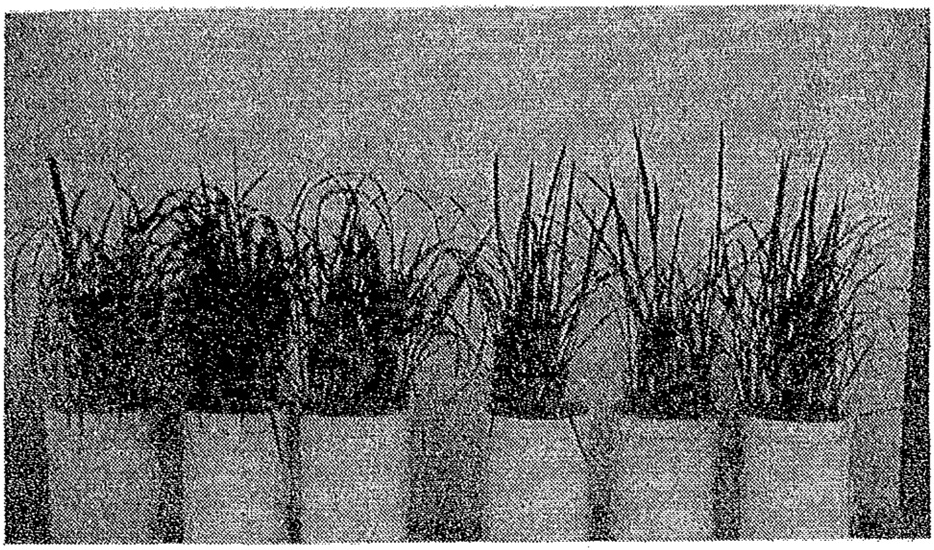
* : kg/ha as a granular formulation

** : ppm in H_2O

Fig. 6. Simetryn - Brassinolide interaction for the growth in rice (Japonica, Nipponbare)

Photographed 7 days after simetryn treatment in pot.

Fourty-day old seedlings were used for this experiment.



	RD-23			Nipponbare			
Brassinolide	0	10^{-3}	10^{-2}	0	10^{-3}	10^{-2}	(ppm)

(17 days)

Fig. 7. Effect of Brassinolide on the rice growth

参考4

REPORT ON STUDY WORK IN
NATIONAL WEED SCIENCE RESEARCH INSTITUTE PROJECT

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JANUARY 30, 1987

PREFACE

During stay in National Weed Science Research Institute (NWSRI), Department of Agriculture, Thailand, from 13th November to 30th January, the author has been asked to work for researches in herbicide physiology by use of radioisotopes, and also for giving advice on the study field to the researchers in NWSRI.

The study work was performed smoothly through the closed cooperative relationships with NWSRI staffs.

The schedules and the research work are herein presented.

It would be his pleasure if the additional studies will be undertaken in future and also if he will have a chance to take on a part.

30th January, 1987

Katsuichiro KOBAYACHI

EXPERIMENTAL STUDY ON SELECTIVE ACTION OF SIMETRYN AND DIMETHAMETRYN ON RICE CULTIVARS AND BARNYARDGRASS

Simetryn [2,4-bis(ethylamino)-6-methylthio-1,3,5-triazine] and dimethametryn [2-(1,2-dimethylpropylamino-4-(ethylamino)-6-methylthio-1,3,5-triazine] are s-triazine herbicides, and widely used in paddy rice field.

Their chemical structure are quite similar, and the similarity in herbicidal action on weeds has been reported, in which the primary herbicidal action of simetryn and dimethametryn seems to be inhibition of photosynthesis. It was found that dimethametryn demonstrated severer phytotoxity to rice cultivars than simetryn. Rice cultivars varied greatly in their sensitivity to simetryn and dimethametryn.

The present study was undertaken to clarify the mechanism of differential responses of rice cultivars through the investigations of their absorption and translocation in the plants by use of ^{14}C-labelled simetryn and dimethametryn.

MATERIALS AND METHODS.

Plant Materials

Rice cultivars, Nihonbare (*Japonica* type), RD-23 (*Indica* type) and KDL-105 (*Indica* type), and barnyardgrass [*Echinochloa crusgalli* (L.) Beau] were used for the experiments. They were grown in a green house in water culture under the natural condition. Two weeks after the germination, the plants reached to the 4-leaf stage of development.

Responses of Plants to Root-Applied Simetryn and Dimethametryn

Roots of plants were placed in serial dilution of simetryn or dimethametryn at concentrations of 0, 10^{-6}, 2.5×10^{-6}, 10^{-5}, 2.5×10^{-5} and 10^{-4} M containing 0.2% acetone and 0.2% Tween 20 in a growth chamber at about 25°C under continuous light illuminate. After 24 hr. treatment, the roots were throughly washed with 1% acetone solution and the plants were transfered to nutrient solution to be grown further 7 days at which time plants were harvested.

Absorption and Translocation of Root-Applied ^{14}C-simetryn and ^{14}C-Dimethametryn

Roots of plants were placed, in the same way described before, in 10^{-5} M of ^{14}C-(triazine-ring) labelled simetryn (specific activity 1.0 mCi/mM) or ^{14}C (triazine-ring) labelled dimethametryn (specific activity 1.0 mCi/mM solution in the growth chamber. After the designated periods of absorption, the plants were removed from herbicide solution and roots were throughly washed with 1% acetone solution. The plants were divided into shoots and roots, and dried at about 60°C.

They were weighed and combusted in an automatic sample oxidizer (Parekard Tricarb 306), and ^{14}C-radioactivity was determined by a liquid scintillating spectrometer system (Parekard 4530).

The treated plants were also prepared for radioautography. Translocation rate of ^{14}C-simetryn and ^{14}C-dimethametryn from roots to shoots was calculated by fitting the following equation :

$$\text{Translocation rate (\%)} = \frac{\text{total radioactivity in shoots (dpm)}}{\text{total radioactivity in whole plant (dpm)}}$$

RESULTS AND DISCUSSION

The effects of root-applied simetryn and dimethametryn were investigated in term of their visible injury symptons on the leaves and dry weights, and the results are shown in Table 1 and 2.

The visible symptoms in leaves such as willing and necrosis was observed in any plants treated with the herbicides at higher concentration. But, the degree, when compared among the rice cultivars and barnyardgrass, was observed most severely in barnyardgrass treated with simetryn and dimethametryn. Nihonbare cultivar, on the contrary, was more tolerant to both simetryn and dimethametryn than the other rice cultivars and barnyardgrass. No significant difference in the degree of growth inhibition induced by simetryn and dimethametryn between RD-23 and KDL-105 cultivars. All of the plants demonstrated more tolerance to simetryn.

The absorption of ^{14}C-simetryn and ^{14}C-dimethametryn by roots of both rice cultivars and barnyardgrass were increased with time (Table 3). The rapid absorption was found in the first 1 hr of exposure period. In ^{14}C-simetryn absorption, the amount of absorption by the roots was much less in barnyardgrass than in the rice cultivars, especially clear during the first 6 hr. of exposure period. At later 6 and 24 hr. exposure, the amount of absorbed ^{14}C-simetryn by RD-23 and KDL-105 cultivars were much more than in Nihonbare cultivar and barnyardgrass. The absorption of ^{14}C-dimethametryn by barnyardgrass was much less than by the rice cultivars at all exposing period tested. The rate of ^{14}C-simetryn was similar to that of ^{14}C-dimethametryn, when compared in the same rice cultivar or barnyardgrass.

It was demonstrated that there was no correlation between the amount of absorption of ^{14}C-simetryn or ^{14}C-dimethametryn and the herbicidal effect.

Data on the translocation rate of ^{14}C-simetryn or ^{14}C-dimethametryn from roots to shoots of these plants are shown in Table 4 (autoradiograph has still been contacted with X-ray film). In all of the plants, it was found that both herbicides rapidly translocated to the shoots in the early exposure period. The rates of translocation of ^{14}C-simetryn and ^{14}C-dimethametryn were much less in barnyardgrass than the rice cultivars except at 24 hr. exposure, but it was found little difference in the rates of translocation of both herbicides in the rice cultivars.

On the other hand, the result demonstrated that the rate of translocation of ^{14}C-simetryn was much higher than ^{14}C-dimethametryn in these plants.

The concentration of ^{14}C from ^{14}C-simetryn or ^{14}C-dimethametryn in shoots and roots of rice cultivars and barnyardgrass is shown in Table 5. Among the plant treated with ^{14}C-simetryn, there was a general trend toward a lower concentration in barnyardgrass shoots than those in the shoots of rice cultivars, although the highest accumulation was found in the roots of barnyardgrass at 24 hr. The similar difference was also found in the roots of the these plants.

The ^{14}C-concentrations derived from ^{14}C-dimethametryn in both roots and shoots of barnyardgrass were the lowest in every exposure time among these plants. It was also demonstrated that the accumulation of ^{14}C-radioactivity derived from ^{14}C-simetryn and its concentration in shoots of all plants should significantly higher than those of ^{14}C-radioactivity derived from ^{14}C-dimethametryn. In contrast, the concentration of ^{14}C in roots was found higher in all of the ^{14}C-dimethametryn-treated plants than in the ^{14}C-simetryn-treated plants. These difference in accumulation of ^{14}C in shoots between the ^{14}C-simetryn-treated plants and the ^{14}C-dimethametryn-treated plants was indicated to be mostly dependent on different translocation rates between both herbicides.

From these results, it was suggested that the difference in the rates of translocation between the herbicides was one of the main factors determing the different phytotoxic action of herbicide among these plants, although further study on metabolisms of the herbicides remained to be investigated.

It was found that there was difference not only in sensitivities to simetryn or to dimethametryn but also in rates of absorption of ^{14}C-simetryn or ^{14}C-dimethametryn among these plant species. However, there was no correlation between their phytotoxities and the rates of absorption and translocation. It can be concluded that both absorption and translocation are not the factors in determing the different phytotoxities of simetryn or dimethametryn among the rice cultivars and barnyardgrass, although it is not clear what chemical, the herbicides or their metabolites, were translocated. The reason for this different sensitivity requires study in connection with the metabolisms of the herbicides in the plants and the mechanisms of their action on photosynthesis.

Table 1. The Phytotoxic Symptom of Simetryn and Dimethametryn on Rice Cultivars and Barnyardgrass.

Herbicides	Varieties	Concentration of Herbicide (m)				
		10^{-6}	$2.5x10^{-6}$	10^{-5}	$2.5x10^{-5}$	10^{-4}
Simetryn	Nihonbare	0	0	0	2.0	2.5
	RD-23	0	0	1.5	2.5	4.5
	KDL-105	0	1.5	2.0	3.0	4.7
	Barnyardgrass	0	1.5	2.5	3.0	5.0
Dimetha-metryn	Nihonbare	0	0	0	2.0	3.7
	RD-23	0	0	5.0	5.0	5.0
	KDL-105	0	0	3.5	4.5	5.0
	Barnyardgrass	1.5	2.0	5.0	5.0	5.0

Table 2. Dry Weight of Shoot and Root of Rice Cultivars and Barnyardgrass at 7 Days after Treatment with Root-Applied Simetryn and Dimethametryn.

Herbicide concentration (M)		Dry weight (% of control)							
		Shoot				Root			
		N	RD	KDL	B	N	RD	KDL	B
10^{-6}	S	115.9	98.8	101.9	81.6	96.2	109.1	78.2	130.6
	D	110.1	90.4	92.9	95.1	120.3	85.2	74.6	95.7
$2.5x10^{-6}$	S	95.4	96.0	72.0	87.2	98.4	85.8	59.5	104.1
	D	105.5	73.2	99.2	102.7	103.3	75.4	89.4	111.2
10^{-5}	S	71.5	59.5	60.8	59.4	66.2	67.6	50.3	69.5
	D	64.9	37.0	38.7	37.2	60.4	27.8	26.9	35.5
$2.5x10^{-5}$	S	51.4	45.0	39.3	43.0	52.5	44.6	31.8	34.3
	D	45.9	37.2	39.5	32.3	37.7	37.6	27.2	21.6
10^{-4}	S	36.3	35.0	31.4	21.6	37.1	47.5	31.4	17.6
	D	28.6	34.5	33.4	28.6	17.8	35.2	24.0	21.4

N = Nihonbare cultivar

RD = RD-23 cultivar

KDL = Khao Dawk Mali 105 cultivar

B = Barnyardgrass

S = Simetryn

D = Dimethametryn

Table 3. Absorption of ^{14}C-simetryn and ^{14}C-dimethametryn by Roots of Rice Cultivars and Barnyardgrass.

Herbicide	Cultivar	Radioactivity Exposure time (h)			
		1	3	6	24
		dpm/mg dry weight of root			
Simetryn	Nihonbare	701.3	957.4	1256.2	2293.2
	RD-23	775.8	1003.2	1706.8	2522.6
	KDL-105	662.5	979.5	2015.0	2525.2
	Barnyardgrass	493.6	729.0	868.5	2183.4
Dimethametryn	Nihonbare	749.5	1063.2	1331.8	2419.3
	RD-23	995.4	851.8	1370.9	2219.4
	KDL-105	948.6	902.4	1443.8	2428.9
	Barnyardgrass	623.4	723.2	1039.0	1705.3

Table 4. Translocation Rate of ^{14}C-simetryn and ^{14}C-dimethametryn from Roots to Shoots of Rice Cultivar and Barnyardgrass

Herbicide	Cultivar	Translocation rate (%) Exposure time (h) 1	3	6	24
Simetryn	Nihonbare	28.4	38.8	54.2	63.4
	RD-23	25.4	40.2	58.5	57.8
	KDL-105	21.8	40.9	64.8	58.5
	Barnyardgrass	9.1	25.9	47.2	56.4
Dimethametryn	Nihonbare	18.1	23.5	24.8	40.6
	RD-23	14.9	17.1	26.3	42.7
	KDL-105	19.3	20.2	27.9	46.6
	Barnyardgrass	11.7	16.5	20.2	46.3

Table 5. Concentration of ^{14}C-radioactivity derived from ^{14}C-simetryn and ^{14}C-dimethametryn in shoots and roots of rice cultivar and barnyardgrass.

Herbicide	Cultivar	^{14}C-concentration			
		Exposure time (h)			
		Shoot 1	3	6	24
Simetryn	Nihonbare	66.1	111.2	252.9	504.8
	RD-23	72.6	126.7	288.9	528.3
	KDL-15	47.7	93.7	260.2	464.9
	Barnyardgrass	34.1	101.0	171.7	618.0
Dimethametryn	Nihonbare	48.2	71.9	107.9	298.0
	RD-23	49.5	54.2	111.1	280.0
	KDL-105	48.4	60.7	116.5	289.9
	Barnyardgrass	33.5	48.0	81.3	273.5
		Root 1	3	6	24
Simetryn	Nihonbare	502.1	585.9	575.3	838.7
	RD-23	578.9	600.0	708.0	1065.6
	KDL-105	518.1	578.3	709.0	1049.2
	Barnyardgrass	422.4	540.4	458.1	951.4
Dimethametryn	Nihonbare	613.9	813.0	1001.1	1438.1
	RD-23	847.0	705.9	1009.9	1270.7
	KDL-105	765.8	719.6	1040.9	1296.1
	Barnyardgrass	550.2	604.1	828.7	915.6

Main Schedules During Stay in Thailand

November 13	Arrival to Bangkok
November 14 – January 29	Study work on herbicide physiology by use of radio-isotopes
November 20	Visit to Hantra Rice Experimental Station
November 21-25	Tour to Southern area : Visit to Songkhla Rubber Research Center, Pattani Rice Experimental Station, Prince of Songkhla University and Phathalung Rice Research Center
January 22-23	Participation in seminar on "Weed Science and Weed Control in Thailand" by Department of Agriculture, Ministry of Agriculture and Cooperatives, Thailand and by JICA, and presentation a paper entitled "Use of Radioisotopes in Herbicide Physiology"
January 29	Report to DOA and JICA
January 30	Leaving Bangkok

PROPOSAL

Radioisotope techniques are useful in the investigation of the mechanism of action and selectivity of herbicide. To use radioisotopes and to operate the instruments effectively and safely, it is desireable to establish the management system concerned with use of radioisotopes. It is important to set up a training course for the biginners to give them more information and techniques of radioisotope usage, because Thai researchers can not avoid of using radioisotopes in Weed Science, especially in herbicide physiology, in near future.

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参考 5

REPORT ON AQUATIC WEEDS MANAGEMENT IN THAILAND

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BACKGROUND

Aquatic weeds interfere with man's ability to appreciate and enjoy water. In many of water bodies all over the world it has been necessary for centuries to control aquatic weeds. This has been done chiefly because the aquatic weeds obstruct the flow of water causing flooding, impeding drainage, and, through increased silting, channel deterioration. There are also other locally important reasons such as navigation, fishing, recreation, health and wildlife nesting. There are several methods of aquatic weeds management : mechanical harvesting, biological control, environmental changes, and chemical control. The methods selected are determined by the particular use of the water body and by available resources. However, negative features are only one aspect of aquatic weeds, there is another site to it. That is many aquatic weeds produce large amounts of biomass which can be potentially used for some beneficial purposes.

On February, 1983, the International Conference on Water Hyacinth was held in India, and many papers dealing with the utilization of this weed were presented. Also Conference on Research and Applications of Aquatic Plants for Water Treatment and Resource Recovery was held in Florida on July, 1986. Today, utilization of aquatic weeds has been considered an important part of its management.

During my stay in the Weed Science Branch, the Botany and Weed Science Division, Department of Agriculture, Thailand from December 2nd, 1986 to January 31st, 1987, I could have some chances to visit some aquatic plant researchers and to get some informations on the status of aquatic weed problems; its control and utilization in Thailand. Also I have been to central, western and southern parts of Thailand for survey of aquatic weeds and for collecting water samples. The purpose of this report is to review the known research findings on aquatic weeds management, and to identify key research needs based on my survey in Thailand.

UNDESIRABLE EFFECTS

The land area of Thailand is 514,000 km^2 and not less than 5% of this land is estimated to be water area[4)]. Water is used for irrigation, transportation, fishing, energy production, drinking and other purpose. So excessive growth of aquatic weeds in water bodies causes the following undesirable effects : (a) choking irrigations and drainage ditches, (b) interfering with boating and fishing, (c) impacting on hydroelectric power, wildlife conservation, public health, recreation and flood control. Thamasara (1983) reported that excessive growth of aquatic weeds in natural water systems is as the result of negligence, whereas in large man-made aquatic habitats it is as the result of disturbance of the natural ecology.

MAJOR AQUATIC WEEDS

Weed Control and Research Branch, Royal Irrigation Department, reported that the major aquatic weeds are *Eichhornia crassipes, Mimosa pigra, Hydrilla verticillata, Potamogeton malainus* and *Coix aquatica*, and that some of the lesser weeds are *Salvinia cucullata, Najas graminea, Eleocharis dulcis, Typha angustifolia, Colocasia esculentum* and *Nymphaea lotus*. All of the collected aquatic weeds during my survey are presented in Table 1.

Table 1. List of aquatic weeds collected around Kanchanaburi, Nakhon Sawan and Hat Yai.

Scientific name	Life form	Scientific name	Life form
Ceratophyllum demersum	S	*Alternanthera philoxeroides*	E
Hydrilla verticillata	S	*Ipomoea aquatica*	E
Myriophyllum tetrandrum	S	*Hygroryza aristata*	E
Najas graminea	S	*Nelumbo nucifera*	E
Ottelia alismoides	S	*Coix aquatica*	E
Potamogeton malaianus	S	*Colocasia esculenta*	E
Utricularia flexuosa	S	*Eleocharis dulcis*	E
Cabomba caroliniana	S	*Limnocharis flava*	E
Azolla pinnata	F	*Ludwigia adscendens*	E
Salvinia cucullata	F	*Monochoria hastata*	E
Pistia stratioites	F	*Monochoria vaginalis*	E
Lemna perpusilla	F	*Polygonum tomentosum*	E
Eichhornia crassipes	F	*Ceratopteris thalictroides*	E
Nymphaea lotus	R	*Marsilea crenata*	E
Nymphoides indica	R	*Bacopa monnieri*	E
Alternanthera sessilis	E	*Limnobium spongia*	E

S = submerged

F = free floating

R = rooted with floating leaves

E = emerged

CONTROL

(1) Mechanical control

The mechanical control for aquatic weed is the oldest method, however it is still practical and advantageous at present. Hand cutting or pulling weeds are employed in some small or shallow water areas, especially for free floating aquatic weeds such as *Eichhornia crassipes, Pistia stratiotes* and *Salvinia cucullata*. In large water areas, the boat with the cutting machine is needed or aquatic harvesters such as H-650, are used to remove plants. However all mechanical control system are expensive. The high reproductivity of many aquatic weeds in Thailand requires that many machines, operating on a constant basis would be needed to obtain the desired control[3,4).

(2) Chemical control

The admistration of herbicides is convenient, a rapid and effective control method of the aquatic weeds, but some types of herbicides are harmful to human health, fishes and aquatic organisms. Herbicides should be carefully employed in the water bodies. In 1983, some herbicides was applied to *Mimosa pigra* infested in the area of 350 ha, while 2,4-D was used to control water hyacinth infested in the area of 300 ha. However, the chemical control of other aquatic weeds in Thailand are limited, and the chemical control is under trials with 2,4-D amine, Glyphosate, Diquat, Paraquat and Silvex.

(3) Biological control

Research and development in biclogical control in Thailand was launched on a nationwide basis with the establishment of the National Biological Control Research Center (NBCRC) in 1975 by the National Research Council of Thailand in collaboration with

Kasetsart University and other academic and governmental agencies. At present, both clossical and contemporary biological control projects are undertaken and carried out for selected insect pests and weeds of economic importance in Thailand. Some successes were achieved especially the use of the waterlettuce moth, *Episammia pectinicornis*, in the control of the waterlettuce. The mottled water hyacinth weevil, *Neochetina eichhornia*, introduced from Florida has become established in the peninsula area of Thailand[2].

UTILIZATION

Many aquatic weeds have created a considerable problem in the water bodies in Thailand, so the development of an effective control has been desired now. Therefore, the concept of the utilization of aquatic weed has not received attention yet. However, as far as I know, only utilization of water hyacinth has been under trials. For example, some pilot scale experiments of wastewater treatment using water hyacinth were conducted at the Division of Environmental Engineering, Asian Institute of Technology[1], at Royal Irrigation Department, or at Division of Physics and Engineering, Department of Science Service. Furthermore some project is undertaken to study the utilization of water hyacinth in Lake Songkla as fish food. Also the study on biogas production from water hyacinth was reported in the annual report of Agricultural Chemistry Division.

On the other hand, when I left on a survey for central, western and southern parts of Thailand, I could see that farmers harvested water hyacinths for use as a pig feed, as a compost or as a material of handicraft.

PROPOSAL FOR FUTURE RESEARCH

As I mentioned before, at present, utilization of aquatic weeds has been considered an important part of its management. Nowadays, both in Japan and in the United States of America, studies refer to utilization of aquatic weeds have focussed on wastewater treatment and gasification system.

Recently Conference on Research and Applications of Aquatic Plants for Water Treatment and Resource Recovery was held in Orlando, Florida. At present, in the U.S.A., sufficient biological, engineering, economic, ecological and environmental data are emerging to make possible the design and operation of water treatment/resource systems using aquatic plants. So the focus of this conference was to assess the usefulness of plants cultured in wetlands, ponds, lakes, streams or channels for water treatment and by-product utilization, and to synthesize and interpret current research and to analyze case studies of operating systems. Also this conference was aimed at two audience groups : 1) scientists and engineers involved in conducting research and 2) plant operators, environmental managers, consulting engineers, and policy-makers involved in the application of the technology. Successful completion of this conference aided in transfer of technology from scientists to applicators for practical application and identification of future research and development needs. One hundred papers from 20 countries were presented, and main aquatic weeds described in contributions were as follows : 1) water hyacinth : 36%, 2) cattail : 15%, 3) duckweed : 9%, 4) bulrush (*Scirpus* sp.) : 8%, 5) reed : 7%, 6) pennywort (*Hydrocotyl umbellata* L.) : 4%, 7) water lettuce (*Pistia stratiotes* L.) : 4%.

Currently, several studies are in progress or planned to evaluate the growth rates of several aquatic weeds and to select plants for high biomass yields except water hyacinth. Also the use of emergent plants such as cattail, bulrush and reed in wetlands for wastewater treatment has received increasing attention.

In near future, for cooperative science program, both Japanese researchers and American researchers are proposing some project entitled "Study on productivity and resource recovery of aquatic weeds". This basic research should be valuable to both countries in solving aquatic weed problems.

On the other hand, in the case of Thailand, many aquatic weeds has grown throughout the year so that Thailand seems to be an ideal location to establish energy farms with aquatic weeds and to get the production of high biomass yields year around. First of all, it is desired that the most appropriate system for water hyacinth utilization will be established. The water quality in the habitat of water hyacinth obtained during my survey is shown in Table 2. It seems that there is a common fact that the habitat of water hyacinth is heavily enriched. Therefore, water hyacinth appears to show promise in the potential use as water purifier. Recently, in Japan, the Waterhyacinth Society of Japan was founded in 1982. The society has over 200 members who are interested in water hyacinth. In addition to domestic activities, we have a strong wish to make a close relationship with scientists and organization of various countries. The exchange between Thailand and our society will be muturally beneficial to the advancement of aquatic weeds management.

In my opinion, basic research for better understanding of the biological, ecological, physiological and economical aspects of the

Table 2. Water quality in the habitats of some aquatic weeds in central, western and southern parts of Thailand.

Location	pH	NH_4-N	NO_3-N	PO_4-P	
Kanchanaburi (pond)	7.19	0.07	0.04	0.11	
Kanchanaburi (pond)	7.20	0.10	0.08	0.11	
Ta-Tong-Na Dam	7.40	0.07	0.11	0.09	WH (small)*
Kanchanaburi (pool)	7.11	0.06	0.01	0.09	
Kanchanaburi (Khwae river)	-	0.08	0.56	0.10	WH (large)
Va-Chiralongkorn Dam	7.33	0.15	0.68	0.09	WH (small,large)
Kanchanaburi (pool)	6.61	0.24	0.00	0.11	WH (small)
Nakhon Pathom (pool)	6.62	0.33	0.00	0.83	WH (large)
Nakhon Pathom (pond)	6.58	0.85	0.00	2.11	WH (large)
Chi Nat Dam	6.83	0.04	0.11	0.10	WH (small,large)
Bung Boraphet Swamp	7.98	0.04	0.09	0.09	WH (small)
Sing Buri (pool)	6.52	0.04	0.00	0.09	
Ayutthaya (pool)	6.19	0.95	0.58	0.09	WH (large)
Thale Noi Lake	6.04	0.14	0.10	0.14	WH (small,large)
Hat Yai (pond)	3.72	0.05	0.00	0.11	
Na Thawi (pool)	6.60	0.56	1.64	2.95	WH (large)
Khok Pho (pond)	5.86	0.12	0.30	0.09	WH (small)
Ban Nong Sata (Pattani river)	5.54	0.04	0.16	0.09	
Yala (pond)	4.81	0.10	0.00	0.11	
Sai Buri (pool)	4.51	0.24	0.11	0.11	WH (small)
Pattani (pool)	6.16	0.16	0.00	0.34	
Pattani (pool)	6.47	0.52	0.00	0.45	WH (large)

* WH : the habitat of water hyacinth

aquatic weeds is necessary for developing the concept of utilizing aquatic weeds in Thailand. I hope that Thailand will be successful in establishing an effective aquatic weed management including utilization.

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MAIN SCHEDULE DURING STAY IN THAILAND

December 2, 1986	Arrival at Bangkok
December 11-12, 1986	Survey and collecting aquatic weeds and water samples around Kanchanaburi
December 15-19, 1986	Visit with some aquatic plant scientists and getting information on the status of aquatic weed problems in Thailand
December 24-25, 1986	Survey and collecting aquatic weeds and water samples around Nakhon Sawan
January 5-9, 1987	Survey and collecting aquatic weeds and water samples in the southern parts of Thailand (Hat Yai, Phatthalung, Narathiwat, Pattani and Yala)
January 22-23, 1987	Attendance at Seminar on Weed Biology and Weed Control in Thailand to be held by Department of Agriculture and JICA, and presentation of a report entitled "Utilization of Aquatic Weeds and its Possibility".
January 31, 1987	Departure

JICA