馬場赳・中川恭二郎専門家帰国報告書

タイ国雑草科学研究所（ＮＷＳＲＩ）の学位取得候補者に対する論文および実験指導に関する報告

昭和57年11月24日

東京農業大学農学部教授

馬場　　越　（雑草生理担当）

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中川恭二郎　（植物保護担当）

日　　程　　表

期　　日	行程および事項
昭和57年8月23日（日）	東京 → バンコク　（バンコク泊）
8月24日（月）午前	日本大使館、ＪＩＣＡ事務所表敬訪問
午後	雑草科学研究所（ＮＷＳＲＩ）視察　（バンコク泊）
8月25日（火）午前	ＮＷＳＲＩにて講演（農業科学研究の方法について）
	ＮＷＳＲＩ所員と懇談　（バンコク泊）
8月26日（水）	Department of Agriculture 表敬訪問
	バンコク → Kamphaengsaen（カセサート大学移転先）（新中央研究棟、新機械化センター、普及センター視察）→ スハンブリ（稲作試験場視察）
	（スハンブリ泊）
8月27日（木）	スハンブリ → アユタヤ（浮稲地帯直播水田の雑草調査）
	→ プラチンブ（寄生雑草Striga asiatica の生育地調査）→ バンコク　（バンコク泊）
8月28日（金）	ＮＷＳＲＩ　Ph－D 取得対象研究者の研究調査
	野田団長および日本人派遣専門家との最終打合せ
8月29日（土）	バンコク → 東京

調　査　報　告

1　既往の経過

タイ国の農業生産は人口増加に対応し、耕地面積の増加を指向し数次の５ケ年計画を通じて総生産額においては各作物ともに成果をあげたが単位面積当り収量は必ずしも増加していない。今後の水田生産力増加は、灌排水の改善などのインフラストラクチアー（社会的基盤）の整備と施肥栽培管理の改善で単位面積当り収量の増加をはかる必要がある。既に主要米作地帯の灌排水改良に日本政府（ＪＩＣＡ）は大きな投資援助を行っている。施肥の増加による病虫害、雑草害の増大が問題であるが、病虫学部門については、かなりの研究部門を容して対応しているが、雑草部門は人容、施設ともに貧弱である。ことに雑草害は耕地のみでなく、水域、非農耕地の環境破壊要因として大きな問題となっている。

タイ農務局は１９７９年日本に対し「雑草科学研究所プロゼクト」（National Weed Science Research Institute Project）の要請があり、ＪＩＣＡの事前調査により援助が始められた。

現在は研究レベルの向上、共同研究、教育を目的として、(1)専門家の派遣、(2)研究試験用機材の供与、(3)タイ研究者の研修（年３～５名、日本での研修）をとりあげ、(1)、(3)は１９７９年～８０年から実施している。

現在、団長野田健児博士、百武博氏、芝山秀次郎博士が派遣されている。また、１９８２年タイ政府の新実験室建設にともない新研究用機械の供与、整備が行われつつある。次に記述するように協力研究の内容のマスタープランと研究分担がきまり、研究が本格的発足の体制にある。研究協力を大きく促進させるとともに、またタイ国の斯界の研究分野の中心となる人材の育成が極めて重要であるが、そのためには学位（Ph-D）を日本でとらせる必要がある。
その要員として既に検討が行われているが、その候補者、研究項目、研究の進め方等を詳細に検討する目的で、馬場赳（東京農業大学教授雑草生理担当）および中川恭二郎（岡山大学農業生物研究所教授雑草防除担当）が派遣されることになった。

2　協力研究の内容のマスタープラン

(1)　タイの雑草の同定と分布図鑑の作成を目標とし日本の専門家とタイ国のカウンターパートとの共同による。

(2)　主要雑草の生物学的特徴（イネ科、広葉、カヤツリ草科、水生等の雑草）

(3)　雑草防除管理と減収評価（直播イネ、移植イネ、畑作物）

(4)　非耕地雑草の生物学と防除、帰化雑草のMimosa Pigra に力を入れる。

(5)　除草剤（除草剤の評価、除草剤生理、除草剤残留）

除草剤の評価試験は圃場試験でタイ側研究者実施中。残留については供与機材で研究を始

めるよう準備中。

(6) そ の 他

雑草防除の最終目標は総合防除であり、その基礎応用研究による防除技術（機械、生態的）の普及への適用のための社会経済的評価を含む。

3 研究陣容と分担（タイ雑草研究計画昭和55年度

計画打合せチーム報告書1982年1月（JICA）参照

4 PH-D取得候補者研究歴

(1) Miss Maneesa Teerawatsakul

38才 カセサート大 B.S. ケンタッキー大 M.S. 研究歴14年

畑作物雑草防除担当。現在(a)トウモロコシ等、寄生雑草Striga asiatica の生物学的研究、(b)Euphorlia の生物学的特性と防除法の研究に従事している。研究歴長く国際学会にも数回出席、1回来日研究業績もある。

(2) Mr. Prasan ongsaroj

35才 カセサート大 B.S. 英バース大、 ブルンネル大 M.S.

雑草研究歴 1年Miss Maneesa についで長い。水田雑草と除草剤評価の研究を担当。

1975年3ケ月日本学術振興会の予算で来日、岡山大学農業生物研究所雑草研究室で中川恭二郎教授の指導で水田雑草コナギ（Monochoria Vaginalis）の発芽、生育および新除草剤ベンチオカーブ使用と温度との関係を研究した。現在、水田雑草、陸稲雑草の防除の指導と普及に関係している。

(3) Miss Patcharin Wanichanantakul

35才 カセサート大 B.S. 英ブルンネル大 M.S.

雑草研究歴7～8年 雑草の生物学および除草剤生理担当。農業研究センター（鴻巣）雑草研究室で6ケ月研修、雑草の休眠を研究した。

(4) Mrs. Kleopan Suwanarak

35才 カセサート大 B.S. カセサート大 M.S.

雑草研究歴10年、ソサイ、果樹の雑草、主に除草剤の評価担当。

(5) Mrs. Kanik Pierpuch

カセサート大 B.S. 米ノースカロライナ大 M.S.

病理部より2年前転入、雑草の生物学担当予定、組織科学研究歴あり。

(6) Mrs. Cha-um Pramasthira

カセサート大 B.S. カセサート大 M.S. 35才

研究歴７～８年、除草剤の残留整理担当、農業技術研究所で３ケ月研修した。

(7) Mrs. Chanpen Prakongoong

カセサート大　B.S　カセサート大　M.S.

研究歴７～８年、水生雑草の生物学担当（特にヒルムシロ属雑草）。

5　当面の対応

(1) Miss Maneesa

a) 現在寄生雑草Striga asiatica の生態生理の研究を開始しているが、種子発芽に困難しており、その解決が当面大切である。

b) その後、外国文献と情報の収集でStrigaの研究がアメリカ、イギリス、インド等で進んでいること、Strigaは日本に生育していないこと、したがって日本での研究が困難なことがわかり、タイ国だけでの研究で博士号取得に必要な新知見の発見が短期間にできるかどうかの早急な検討を要する。

c) Miss Maneesa は９月の人事移動でChief, Weed Control Seetion（雑草防除科長）に昇進したこと、次席の研究者がＦＡＯの資金でアメリカへ留学することなどで優秀な専門家の長期の派遣（６ケ月位）がなければタイ国での早急な研究の発展は困難のように思われる。

d) 日本において研究を行なわなければ研究の進展が期待できないとすると、Strigaと同じく寄生雑草であり、しかもしかも日本において研究可能なネナシカズラCuscuta Pentagonaを研究し、Striga と Cuscutaを比較研究する方法も検討に値する、Cuscutaのタイ国における被害の現状を照会中である。

なお、最近アメリカネナシカズラが日本に帰化しつゝあり各地で被害が発生し一部で研究が開始されているのでこれがタイ国でも有害な雑草であれば来日して研究しStrigaとCuscuta を比較研究する方法も考えられる。

e) 寄生雑草の研究は、研究方法等で病菌寄生の研究に類似する点も多いので、今回病気のためＮＷＳＲＩに同行できなかった東京農業大学植物病理研究室の藤井博教授の次回の派遣指導をうける必要がある。

f) 早急にMiss Maneesa の論文博士号のテーマと研究方針を定め、専門家のタイ国派遣計画および本人の来日研修計画を定め早く実行する必要がある。

g) Euphorbia geniculata（トウダイグサ科）の研究も有害種が日本にないのと現地での情報不足で検討ができない。

(2) Mr. Prasan

博士号取得には担当する水田雑草およびその防除に関連した研究領域のうちで研究課題を選定することが必要である。本人は指導普及にも関心があるが、基本的には、将来、研究と

普及、行政のいずれかを選択する必要がある。

(3) そ の 他

近く来日するMrs. Champen は本人の積極性と研究の意欲、実行力等から水性雑草の生態生理について研究テーマを選定して重点的に研修を行い論文作成を経験すれば数年の継続研究と再度の来日研修で目的の論文を作成する可能性があると推測される。

6 携行機材

現地での土壌のPH、Ehの迅速測定器を携行したが、Strega発生地の土壌条件の測定には有効であった。現地で入手困難な植物ホルモンも持参したがStriga の発促進に有効に働くことを期待している。

7 今後の論文博士号取得上の問題点

(1) 既に現地でかなりの研究実績をもっている研究者であれば2回の研修で論文の作成の可能性があろう。

(2) 研究実績のあまりない、または少ない研究者の場合は、特定の将来性ありと思われる研究者に早く研究実績をもたせる必要がある。しかし特定研究者だけを現地で援助することは対人関係で度々問題が生ずる可能性があり、国によりカースト制度の存在、勤務時間の制限等で予想以上のむずかしさがあるのが現状である。

本人の上司が博士号をとらせることに心から期待しているのかどうかの問題もある。したがって将来性のある研究者を選んで日本でも研究可能な適切なテーマで在日中に研究の主体を短期間に完成することが望ましく、その受け入れ体制および具体的方法を検討する必要がある。

アメリカにくらべ研究陣容が不充分で目的の研究テーマで博士論文作成の指導ができる人のいない分野もあることを予め検討しておくことも必要である。何れにしても目的を達成するのには、援助開始からのチームリーダーの心がけとその目的での専門家の派遣指導が望ましい。

基本的には研究援助で海外派遣される研究者の多くが博士号をもつように配慮することが必要である。大学は勿論産業庁の研究機関、殊に基礎研究を担当している機関や部門の研究者の協力がえられる体制も期待される。また開発途上の各国の国立研究機関では、政治上の人事問題、カースト制度、習慣の相違などで特定の人材を選んで養成することが意外に困難であるので、これらの問題の少ない熱帯圏での日本の影響力の大きい国際的研究機関等での協力体制も期待される。

(3) 論文博士取得計画を成功に導くためには、十分の予算の裏付けが必要である。現在、一般技術援助の枠内で行われており、課題の枠内という制約がある。人材養成を主目的としての

計画と予算の早期確立が期待される。また現在論文博士取得に関係者の個人的奉仕による処が大きく、目的に応じて最適の専門家の協力をえることが困難である。そのための予算の確保殊に必要に応じて多数の協力者もえられるよう予算および手続上の配慮が期待される。

窪田文武専門家帰国報告書

STUDIES ON SOME ECO-PHYSIOLOGICAL ASPECTS OF *ZEA MAYS* AND *EUPHORBIA GENICULATA* COEXISTED

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25th January, 1983

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Contents

Preface

Based on the application of the Thai Government I had been dispatched as a JICA short term expert at National Weed Science Research Institutes Project, Bangkok, two months from 26th November, 1982 to 25th January,1983. During this period I have been an assignment of making researches in cooperation with the researchers of NWSRI and to instruct them some effective methods and techniques related to the Weed Science research.

In order to achieve the above-mentioned purpose, I have taken up some experiments from the viewpoint of the competition between Zea mays and Euphorbia geniculata. Euphorbia geniculata is well known as a harmful weed in the corn field of Thailand. As a first step towards the actual weed control in the field it is necessary to get some basic information such as ecological and physiological features of the crop and weed, and morphological changes of canopy structure and roots system with the crop-weed coexistence .

The planning and actual research works were carried out cooperatively with my counterparts, Miss Maneesa Teerawatsakul and Mr. Somchart Kanjanajirawong. Four different experiments were conducted in our research, three of which were done in the net house of the NWSRI, and another one was carried out in the field of Phra Puttabat Experiment Station of DOA.

The results reported here, though including some insufficient parts, may domonstrate several interesting points. I do hope that such insufficient data will be reconfirmed in the future by means of Thai researches' efforts using experimental procedures indicated in this report.

Introduction

Euphorbia geniculata is one of the most harmful weeds, causing a large reduction in field crop production in Thailand. This weed appears most frequently in the field with a fertile soil, presenting a vigorous growth to reach sometimes up to near two meters in height. This weed may be regarded as oppressing the crop continuously throughout the whole cropping season.

Corn is a main crop in the upland area of Thailand. Since corn is usually grown on the fertile soil sufficiently fertilized, inevitably Euphorbia geniculata may rapidly grow dense under such a good condition and come up to compete intensively with corn.

The purpose of this research is to get some basic information necessary to control Euphorbia geniculata in the corn field. Here I intended to clarify the ecological and physiological features in the growth of both plants on the dry matter production theory.

This research consists of four experiments. The experiment 1 to 3 were conducted in the net house of the NWSRI. The influences of light and water on growth were examined in the experiment 1 and 2, and both were reported here. In the experiment 3 the investigation of roots competition was planned, but the experiment has been unseccessful because of the very poor germination caused by the extremely low air temperature around the middle of December. Re-trials are necessary for this experiment in the future.

The experiment 4 was made in the field of the Phra Puttabat Experiment Station of DOA, where the canopy structure and root system of Zea mays and Euphorbia geniculata have been planned to investigate. Both the experiment 3 and 4 are planned to be continued by my counterparts and others, and the experimental results obtained should be published in future.

Some Eco-physiological Aspects on Zea mays and Euphorbia geniculata

Experiment 1

Influences of light intensity on the dry matter production of Zea mays and Euphorbia geniculata.

At the beginning stage of growth when plants are small and can keep enough space for their growth, the competition can never occur. However as plants graduately increase in height, depth and size with growth and the remaining space for plants becomes smaller, unavoidably plants compete with each other, then entering into a serious competition. Usually throughout the growth period except the earliest stage, crop and weeds in a field are continuously influencing each other and competing for life factors such as light, water and nutrients.

Of these factors, light, which is needless to say a factor directly related to photosynthesis, may be a most important competing factor in the aboveground sphere of community especially after the middle stage of growth when the mutual shading in the community becomes intensive. In the experiment 1, Zea mays and Euphorbia geniculata were grown under different light intensities to compare and clarify the response of their growth to light.

Materials and Method

The seeds of Zea mays and Euphorbia geniculata were sown 8 and 25 in number, respectively, on a pot with one liter capacity on 5th Dec.,1982, and after being germinated they were thinned to 3 and 20 plants per pot, respectively. As an experimental soil, the soil of the upland corn area was used. As fertilizer, ammonium sulfate, calcium superphosphate and potassium sulfate were applied 2,2 and 1 g to a pot, respectively, i.e. N, P_2O_5 and K_2O each is 0.4 g to a pot.

After being grown at the natural light intensity for two weeks after sowing, the plants were placed under the different light intensities for two weeks from 20th Dec., 1982 to 5th Jan., 1983. The different four light intensities were created by using the shading net cloth. That is 100% full sunlight (no shading), 70% (30% shading), 60% (40% shading) and 30% (70% shading). For the 30% shading a white net cloth was used, and both for the 40% and 60% shading a single and double black net cloth were used, respectively.

The first sampling of Zea mays and Euphorbia geniculata was made with six pots each on 20th of December (the day of treatment beginning). The next sampling of them was carried out on 5th of January. The factors such as the dry matter weight of leaf, stem, root and whole plant, leaf area, specific leaf area, plant height and root length were investigated. The leaf area was measured with the automatic leaf area meter. Based on the investigated factors, Crop Growth Rate (CGR), Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) were calculated to analyze the response of dry matter production of plants to light intensity. The equations for CGR, RGR and NAR are shown below.

$$C\,G\,R = \frac{W_2 - W_1}{t_2 - t_1} \qquad (g / m^2.day)$$

$$R\,G\,R = \frac{1}{W} \cdot \frac{dW}{dt} = \frac{d(\ln W)}{dt} = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

$$(g / g\ m^2\ day)$$

$$N\,A\,R = \frac{1}{F} \cdot \frac{dw}{dt} = \frac{(W_2 - W_1) \cdot (\ln F_2 - \ln F_1)}{(t_2 - t_1) \cdot (F_2 - F_1)}$$

$$(g / LA\ m^2.day)$$

Where t, W and F are the time, dry matter weight and leaf area. When the time is t_1 and t_2, the dry matter weight is W_1 and W_2/m^2, and the leaf area is F_1 and F_2/m^2, respectively.

Results

Table 1 shows the changes of dry matter weight and other characters of Zea mays and Euphorbia geniculata with light intensity. The treatment period was the two weeks from 20th Dec. to 5th Jan. The plant height and stem length of Zea mays and Euphorbia geniculata changed with light intensity, becoming higher or longer under lower light intensity. However, the leaf number and root length were little influenced by the change of light intensity.

The dry matter weight of leaf, stem, root and total plant decreased with the reduction of light intensity. The decreasing rate of them was different from each other. That is, the root weight was more depressed than the other parts both in Zea mays and Euphorbia geniculata. The rate of decrease in the dry matter weights of Zea mays was steeper than that of Euphorbia geniculata. For example, the total weight of Zea mays was 8.46 g/ pot at the 100% light intensity and 3.66 g/ pot at the 30% light intensity, their ratio showing 1 to 0.43, and that of Euphorbia geniculata was 2.83 g / pot and 1.63 g / pot, respectively, shown as 1 to 0.58.

The top/root ratio increased with light reduction, which was more seriously shown in Zea mays.

The leaf area of Zea mays was highest at a light intensity of 70 or 60% but that of Euphorbia geniculata became higher with light reduction. Also the specific leaf area of both plants increased with light reduction.

The photosynthesis of plant is closely associated with the leaf area (LA).

Also the leaf area is determined by leaf weight (LW) and specific leaf area (SLA), that is, LA = LW x SLA. When LW is same, the plant with a higher SLA may have a larger LA.

In Fig. 1 the changes of LA, LW and SLA are presented in ratio. The LW of Zea mays was almost constant at a light intensity of 100% down to 70%, then decreased with a light reduction of 60 to 30%. The LW of Euphorbia geniculata decreased linearly with a light reduction of 100 to 30%. The LW of both plants decreased to 60% or less at the 30% light intensity. Contrary, the SLA of them rapidly increased with light reduction. Expecially in Euphorbia geniculata the SLA at the 30% light intensity rised as high as 220%. The highest LA was obtained at the 60 to 70% light intensity for Zea mays, but for Euphorbia geniculata the highest was shown at the 30% light intensity. There may be a difference in the light response of leaf area, related to LW and SLA, between Zea mays and Euphorbia geniculata.

The crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) of Zea mays and Euphorbia geniculata at each light intensity were calculated and are shown in Table 2. The CGR, RGR and NAR all decreased with light reduction.

Fig. 2 shows the influence of light intensity on the CGR of Zea mays and Euphorbia geniculata. The CGR of Zea mays was by far higher than that of Euphorbia geniculata (Fig. A). As shown in Fig. B the gradient of CGR with light was different between both plants. That is, in Zea mays the CGR was little influenced by light reduction in the range of light intensity from 100% to 70%, on the other hand, the CGR of Euphorbia geniculata decreased linearly with light reduction. At the 30% light intensity the CGR of Zea mays and Euphorbia geniculata was depressed to 35% and 55% of the values at the 100% light intensity, respectively. Under the condition a little

shaded, the CGR of Euphorbia geniculata more decreased than that of Zea mays, contrary, under a heavy shaded condition the CGR reduction became more serious in Zea mays.

Fig. 3 shows the influences of light intensity on NAR (Fig. A) and RGR (Fig. B) of Zea mays and Euphorbia geniculata. The NAR of both plants decreased linearly with light reduction. Their decreasing gradient was almost similar, while under the lowest light condition the NAR of Euphorbia geniculata was nearly twice that of Zea mays. The RGR of both plants also decreased with light reduction. The RGR of Euphorbia geniculata showed considerably higher value than that of Zea mays, which may mean that Euphorbia geniculata has a higher efficeincy in productivity than Zea mays.

Here, as the first step of experiment, the dry matter production of Zea mays and Euphorbia geniculata was analysed and compared in relation to light intensity. Some differences were clarified in the response and adaptability to light reduction between Zea mays and Euphorbia geniculata. As the second step, the physiological features and differences about the light response of these plants must be examined in more detail from the point of view of photosynthesis, evaporation, water and nutrient absorption.

Table 1 Changes of dry matter weight and other characters of Zea mays and Euphorbia geniculata with light condition.

Sampling date		Zea mays					Euphorbia geniculata				
		20, Dec.	5, Jan. Light intensity(%)				20, Dec.	5, Jan Light intensity(%)			
			100	70	60	30		100	70	60	30
Leaf No.		4.1	6.7	6.5	7.0	6.7	1.0	6.0	5.8	5.5	6.7
Height (cm)		26.8	63.2	67.0	76.4	77.5	6.0	18.0	20.8	21.6	23.8
Stem length (cm)		7.2	18.5	17.2	21.3	19.6	7.0	19.4	22.4	22.4	25.8
Root length (cm)		36.7	41.2	35.8	46.2	42.6	-	20.2	22.6	23.2	21.6
Dry matter weight (g/pot)	Leaf	0.42 (36)	3.42 (40)	3.51 (44)	3.04 (47)	1.91 (52)	0.14 (50)	1.17 (41)	1.01 (44)	0.86 (43)	0.68 (42)
	Stem	0.23 (20)	1.83 (22)	1.79 (22)	1.40 (22)	0.84 (23)	0.11 (39)	0.95 (34)	0.89 (39)	0.70 (35)	0.68 (42)
	Root	0.51 (44)	3.21 (38)	2.74 (34)	2.01 (31)	0.91 (25)	0.03 (11)	0.71 (25)	0.39 (17)	0.34 (17)	0.27 (17)
	Total	1.16 (100)	8.46 (100)	8.04 (100)	6.45 (100)	3.66 (100)	0.28 (100)	2.83 (100)	2.29 (100)	2.00 (100)	1.63 (100)
T/R ratio		1.27	1.63	1.94	2.23	3.00	8.09	3.00	4.88	4.88	4.88
Leaf area (cm^2)		206	1115	1464	1474	1350	48	463	508	516	588
Specific leaf area (cm^2/g)		491	326	417	458	575	346	396	503	636	864

* Cotyledon is not included in the number of Euphorbia geniculata.

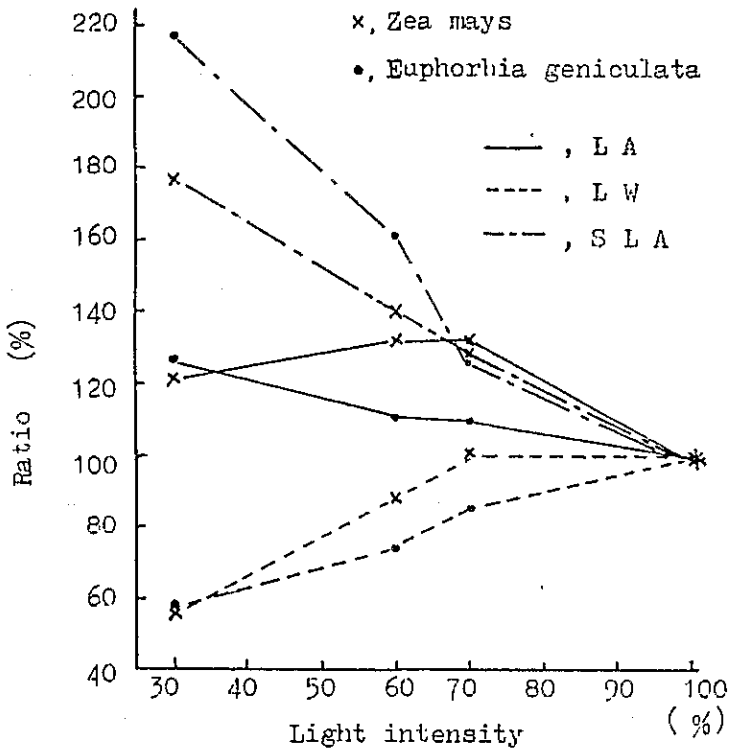


Fig. 1 Influences of light intensity on Leaf Area , Leaf Weight and Specific Leaf Area of Zea mays and Euphorbia geniculata (the ratio is shown to the value at 100 % light intensity).

Table 2. Crop Growth Rate, Relative Growth Rate and Net Assimilation Rate of Zea mays and Euphorbia geniculata at different light intensities.

	Zea mays				Euphorbia geniculata			
	Light intensity (%)				Light intensity (%)			
	100	70	60	30	100	70	60	30
C G R (g/pot)	0.52	0.49	0.38	0.18	0.18	0.14	0.12	0.10
R G R (g/g.day)	0.142	0.138	0.123	0.082	0.165	0.150	0.140	0.126
N A R (g/LAm^2. day)	9.64	7.63	5.89	2.95	9.81	7.16	6.08	4.63

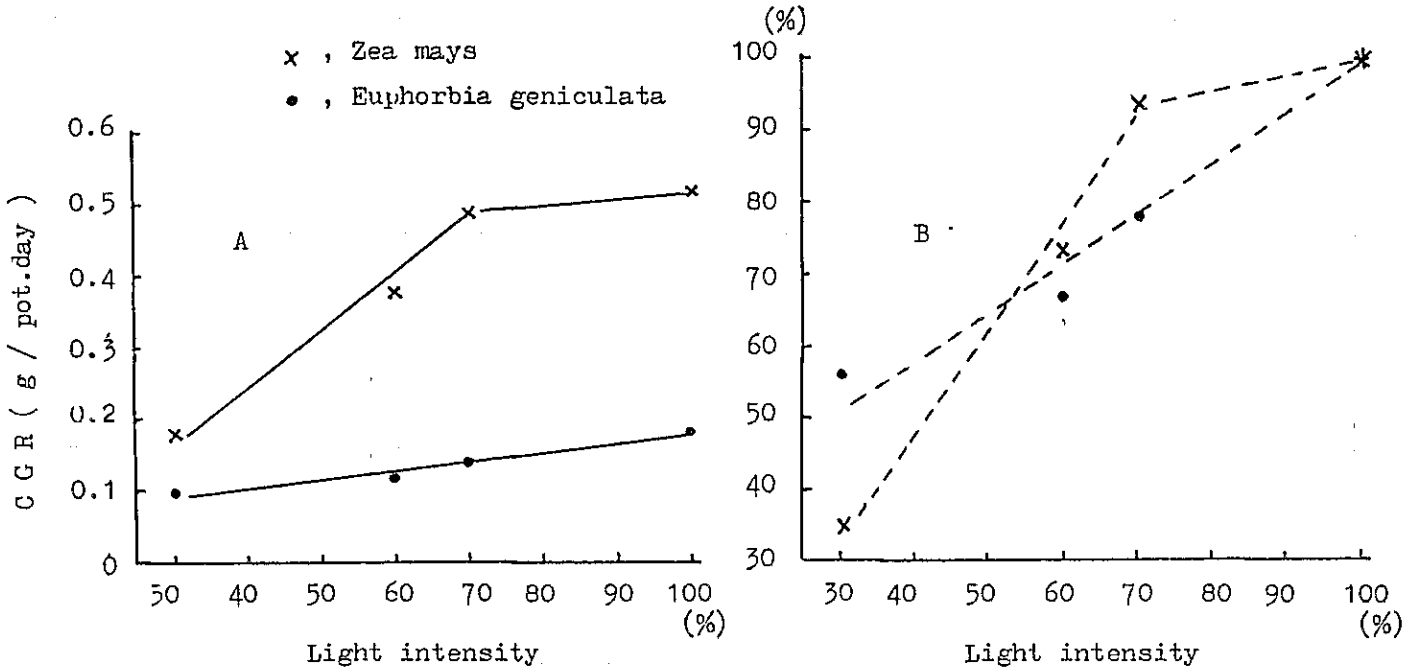


Fig. 2 Influences of light intensity on Crop Growth Rate of Zea mays and Euphorbia geniculata (A, actual values ; B, the ratio to the CGR at 100 % light intensity)

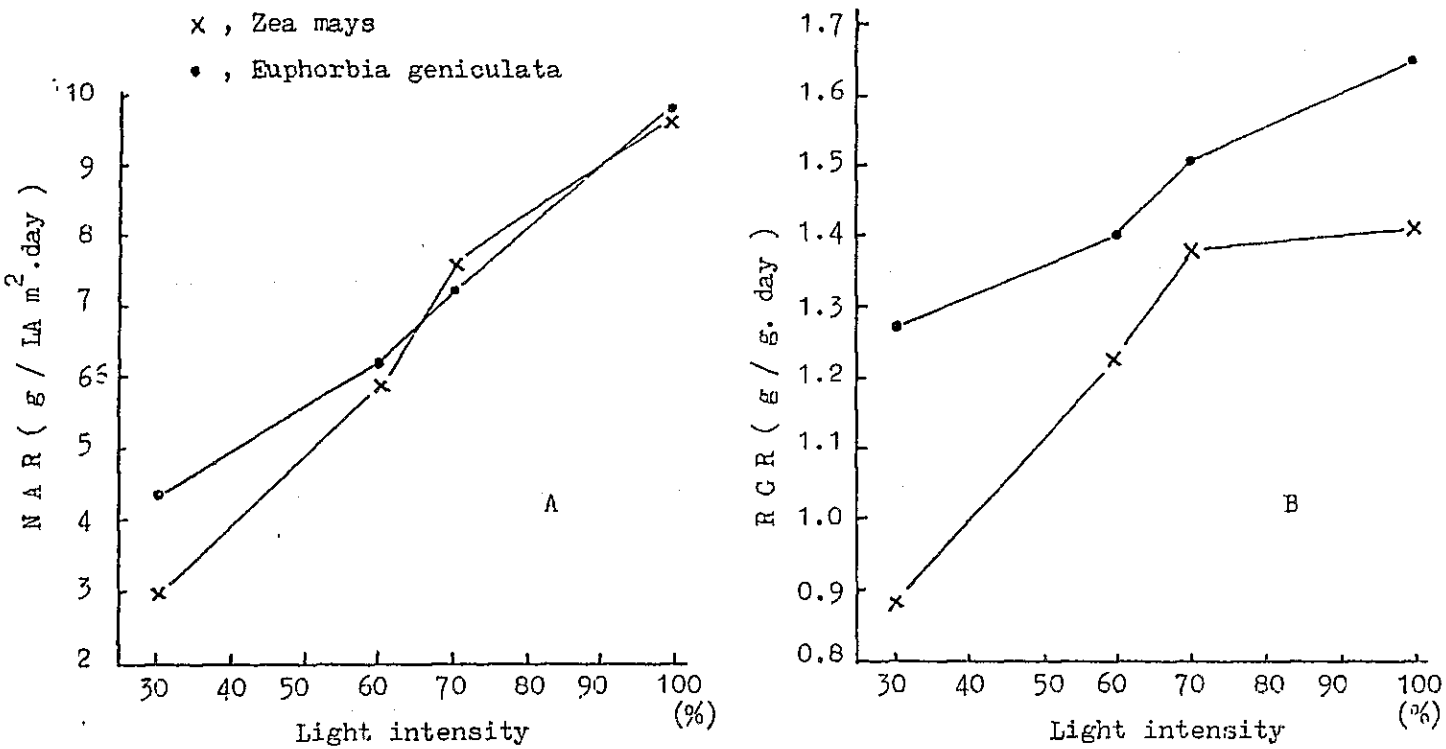


Fig.3 Influences of light intensity on Net Assimilation Rate (A) and Relative Growth Rate (B) of Zea mays and Euphorbia geniculata.

Experiment 2

Comparison of transpiration between Zea mays and Euphorbia geniculata

The influence of light to plant growth has been examined in the experiment 1. Water is another important factor in plant growth. As a plant community becomes crowded at the later stage of growth, the transpiration from leaves increases and sometimes may bring about a serious water deficiency in plant and cause competition for water in root portion. Unlike light for which competition occures only in aboveground, the water competition is more complicated, because the water situation of plant is strongly influenced both: by transpiration of leaves (aboveground environment) and water absorption by roots (underground environment).

As a pre-experiment towards the analysis of water up take on root system, I tried here a simple experiment to examine the feature of the transpiration rates of Zea mays and Euphorbia geniculata.

Materials and Method

Materials used were Zea mays grown in pots and Euphorbia geniculata grown in fields. The former was at the stage with a five to six leaf number and the latter was about 30 to 40 cm in height. The measurement of transpiration was conducted for several days from 23th to 29th Dec., 1982. The soil and fertilizing level were the same as those of the experiment 1.

These plants were carefully dug out of soil and then supplied with a sufficient water for one night before transpiration measurement. On measuring the transpiration the plants were stood on the flask (100 or 200 cc) which were filled with water and completely covered with aluminium foil to prevent water from evaporating out of the mouth of flask and also sunlight from directly

hitting the roots. The reduction of weight by the transpiration was measured periodically (every 60 minutes) from morning to evening. In addition, as a control, the evaporation from a wet filter paper was measured simultaneously.

The number of plants used for the transpiration measurement was quite many, but some of them, especially many of Euphorbia geniculata, were wilted out during the measurement. The data of such plants were excluded here. The data obtained from the plants which could keep rigidity throughout the measurement were used. Also the transpiration was measured under the condition shaded by a net cloth, because the direct sunlight was considered too strong.

Next, I investigated the wilting rate of detached leaves as a criterion of drought resistance to compare its difference between Zea mays and Euphorbia geniculata. On investigation, leaves were cut off from stem, immediately after which the edge of the leaves was sealed with vaseline to stop the water movement from the cut end to the upward part. Then the wilting rate or decreasing rate of leaf weight was measured periodically under the artificial illumination.

The factors investigated here were the weight of plant, leaf area, light intensity, air temperature, vapor pressure and relative humidity. On the basis of these factors the transpiration rate, evaporation rate and their resistances were calculated.

The procedures of calculating relative humidity, transpiration rate, evaporation rate and resistance are shown below.

(1) Relative humidity

The relative humidity of atmosphere can be calculated from the temperature difference between dry and wet bulbs of the thermometer which was placed in the flowing air (3 to 5 m/sec) condition. The relative humidity (RH) is

obtained from equation (1).

$$RH = \frac{e}{Sd} \quad \text{---------} \quad (1)$$

$$e = Sw - 0.5\,(Dt - Wt) \times 760 / 755 \quad \text{----------} \quad (2)$$

Where Dt and Wt are temperatures of the dry and wet bulbs of thermometer, and Sd and Sw are saturated vapor pressures at the temperature of Dt and Wt, respectively. The saturated vapor pressure (S) is usually presented in Hg mm and calculated in relation to air temperature (t) from equation (3).

$$S = 4.7426032 + 0.29439443.t + 0.014113125.t^2 + 0.61380212.10^{-4}.t^3 + 0.48140241.10^{-5}.t^4 \quad \text{----------} \quad (3)$$

(S, Hg mm ; t, °C)

The deficiency (DEF) of vapore pressure in atmosphere is shown as equation (4).

$$DEF = Sd\,(1 - RH) \quad \text{----------} \quad (4)$$

2 Transpiration rate

Usually the transpiration rate (T) is presented as a value of H_2O g per 100 cm^2 leaf Area.Hr

$$T = \frac{(W1 - W2) \times 60 \times 100}{(T2 - T1) \cdot L} \quad \text{----------} \quad (5)$$

Where W1 and W2 are values (g) weighed at the time of T1 and T2, (T2-T1) is the measuring interval (min.) and L is leaf Area (cm^2). When the surface area (cm^2) of the filter paper used for evaporation measurement is induced into L in the equation (5), the evaporation rate of the filter paper can be obtained.

The relationship among transpiration (T), its resistance (R) and vapor pressure (e) are presented as equation (6).

$$T = \frac{e_{leaf} - e_{air}}{R} \times 0.36 \quad \text{----------} \quad (6)$$

(T, g/100 cm^2.hr ; R, sec/cm ; e, Hg mm)

$$R = r_{leaf} + r_{air} \quad \text{----------} \quad (7)$$

Where r means the resistance (sec/cm) in transpiration ; r_{leaf} is the resistance of leaf and r_{air} is the resistance raised between leaf surface and atmosphere. e_{leaf} (Hg mm) and e_{air} are the vapor pressure on leaf surface and in atmosphere, respectively. Since the leaf surface is usually in a situation of almost 100% in relative humidity, e_{leaf} may be regarded as the same value as Sd. The total resistance (R) can be calculated based on the values of T, e_{leaf} and e_{air}.

The evaporation resistance (Re) is calculated from equation (8).

$$Re = \frac{e_{filter} - e_{air}}{r_{air}} \quad \text{----------} \quad (8)$$

Where e_{filter} is the vapor pressure on the surface of wet filter paper, that is, e_{filter} is equal to the saturated vapor pressure (Sd).

Result

Table 1 and 2 show the climatic condition, transpiration rate of plants and evaporation rate of filter paper. The relative humidity was considerably low both in Table 1 and 2, showing around 30 to 40%. The transpiration rates of *Zea mays* were higher than those of *Euphorbia geniculata*. While the transpiration resistances were higher in *Euphorbia geniculata* than in *Zea mays* and were by far higher than the evaporation resistances of filter paper.

Fig. 1 is made based on the data of Table 1. The transpirational difference between Euphorbia geniculata and Zea mays appeared clearly. The transpiration rates of these plants decreased with light reduction.

There seem to be some problems in the above experiments. The first problem is in that the plants used here were transplanted from the soil cultivation (field or pot) to the water cultivation (flask) only a half day before the measurement of transpiration. The transplanting may considerably damage the roots system to prevent the smooth water absorption. It is necessary to retry the experiment with better materials. Next, since generally the transpiration rates seem to vary with growth stage, many measurements must be conducted at the different growth stages.

Fig. 2 and 3 show the wilting rate or weight decrease of detached leaves of Zea mays and Euphorbia geniculata both of which were exposed to a lower (10 klux) and higher (30 or 60 klux) light intensity. The leaf weight of Zea mays decreased with illuminating time more rapidly than that of Euphorbia geniculata. Fig. 3 shows the weight changes of water contained in the detached leaf of Zea mays and Euphorbia geniculata. The former decreased a little faster than the latter.

All the results in Table 1 and 2, and Fig. 1 to 4 showed that the transpiration rate Zea mays was always higher than that of Euphorbia geniculata. However, this fact may not necessarily mean that Euphorbia geniculata is always more tolerable to a drought condition than Zea mays. In order to clarify the transpirational feature and drought resistance, the more detail experiment; under various environments must be carried out. Also the transpiration must be basicly examined in relation to photosynthesis, because both are physiologically connected closely to each other. The experiment in this field should be possible when the apparatus which can read both transpiration and photosynthesis simultaneously and automatically is provided in the NWSRI in the following fiscal year.

Table 1 Climatic factors, transpiration rate and resistance of Zea mays and *Euphorbia geniculata*, and evaporation rate and resistance of filterpaper.

	Climatic factors				Zea mays		Euphorbia		Filterpaper	
Time	Light	Temp.	RH	DEF	Transp.	Resist.	Transp.	Resist.	Evapo.	Resist-E
(hr)	(x10Klx)	(C)	(%)	(Hgmm)						
11:25	5.0	27.7	42.3	16.0	1.60	3.65	0.96	6.54	4.09	1.41
12:25	4.7	28.8	37.1	18.7	1.13	5.98	0.71	12.5	3.95	1.70
13:25	4.0	28.7	37.2	18.5	1.22	6.66	0.52	14.0	3.74	1.79
14:25	3.2	28.8	37.0	18.7	0.88	7.68	0.47	15.1	3.74	1.79
15:25	2.2	28.5	39.0	17.8	0.73	8.85	0.49	13.9	3.75	1.71
16:25	0.9	26.5	45.4	14.2	0.58	10.7	0.28	20.1	1.76	2.89
17:25										

Notes ; Temp., air temperature ; RH, relative humidity ; DEF, deficiency of vapor pressure of atmosphere ; Transp., transpiration rate (g/100 cm^2.hr) ; Resist., transpiration resistance (sec/cm) ; Evapo., evaporation rate (g/100 cm^2.hr) ; Resist-E, evaporation resistance (sec/cm)

Table 2 Climatic factors, transpiration rate and resistance of Zea mays and Euphorbia geniculata, and evaporation rate and resistance of filterpare.

Time (hr)	Climatic factors				Zea mays		Euphorbia		Filterpaper	
	Light (x10Klx)	Temp. (°C)	RH (%)	DEF (Hgmm)	Transp.	Resist.	Transp.	Resist.	Evapo.	Resist-E
11:30	2.80	28.7	30.5	20.5	1.180	6.26	0.967	8.36	3.37	2.19
12:30	2.75	29.6	27.5	22.6	0.897	9.107	0.733	7.33	3.51	2.31
13:30	1.95	29.2	27.6	22.0	0.657	15.74	0.533	16.1	2.69	2.34
14:30	1.60	29.3	29.3	21.6	0.953	8.51	0.433	18.0	2.39	3.24
15:30	1.25	28.9	31.7	20.4	0.743	10.1	0.433	20.0	2.15	3.41
16:30	0.50	26.4	37.7	16.1	0.253	22.8	0.203	32.2	1.66	3.48
17:30										

Notes : Temp.,air temperature ; RH,relative humidity ; DEF, deficiency of vapor pressure of atmosphere ; Transp.,transpiration rate ($g/100cm^2.hr$) ; Resist.,transpiration resistance (sec/cm) ; Evapo.,evaporation rate ($g/100cm^2.hr$) ; Resist-E,evaporation resistance (sec/cm).

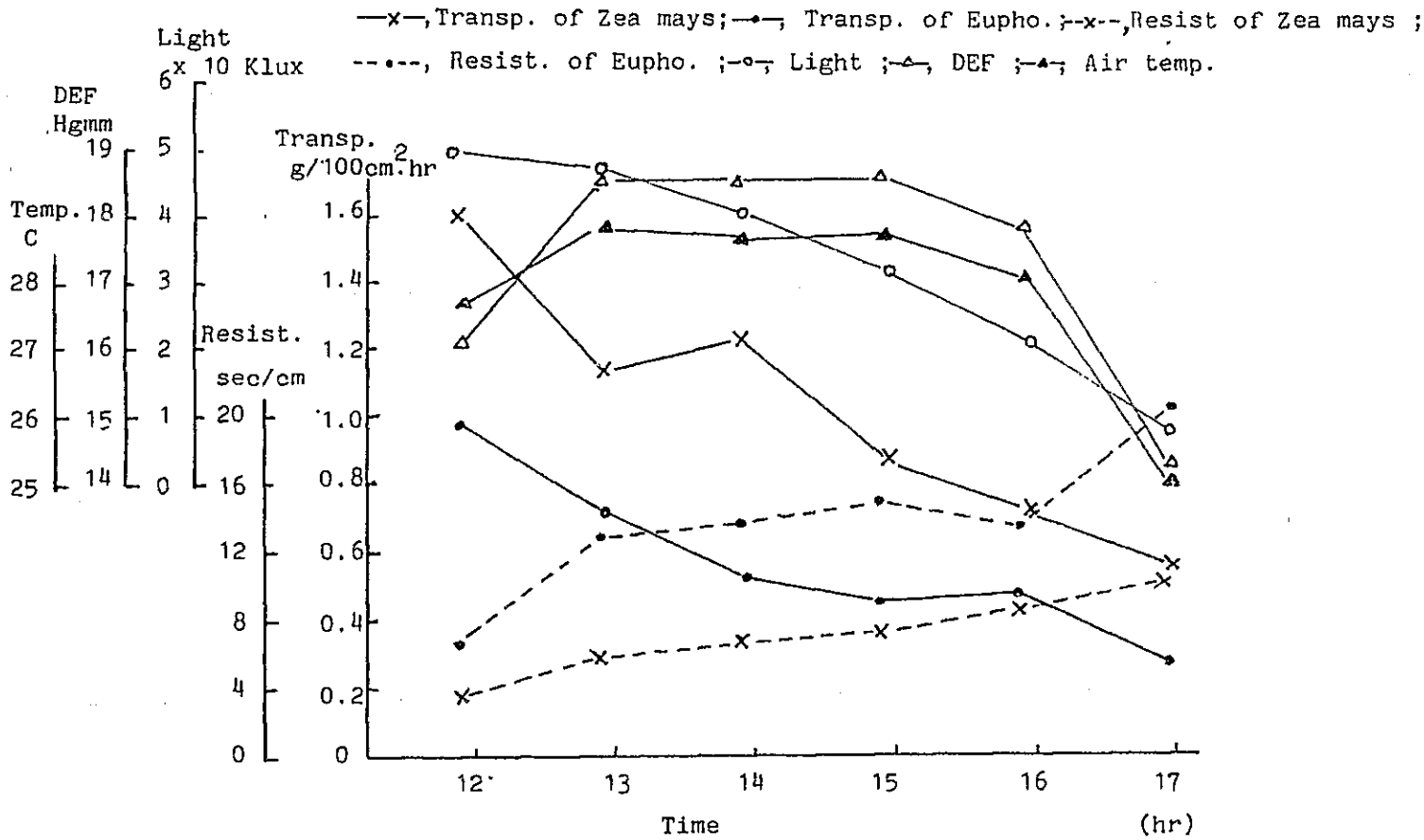


Fig.1 Changes of climatic factors, and transpiration rate and resistance with time. (Transp., transpiration rate ; Resist., transpiration resistance ; DEF, deficiency of vapor pressure in air)

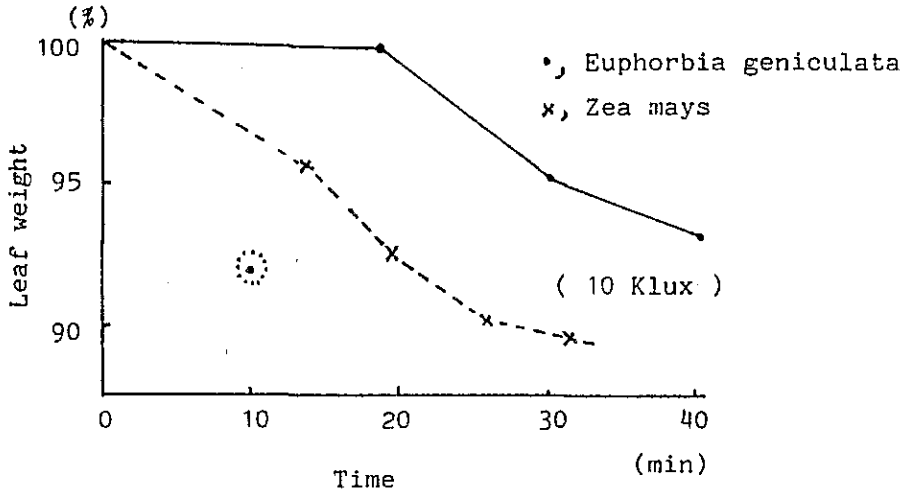


Fig.2 Changes of detached leaf weight with time under the illumination.

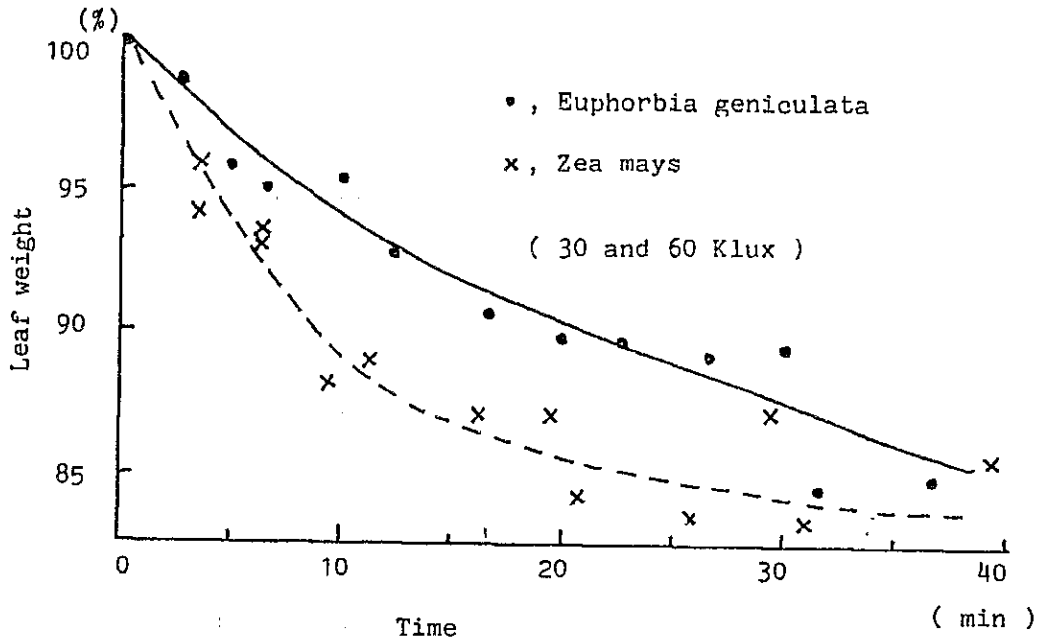


Fig.3 Changes of detached leaf weight with time under the illumination.

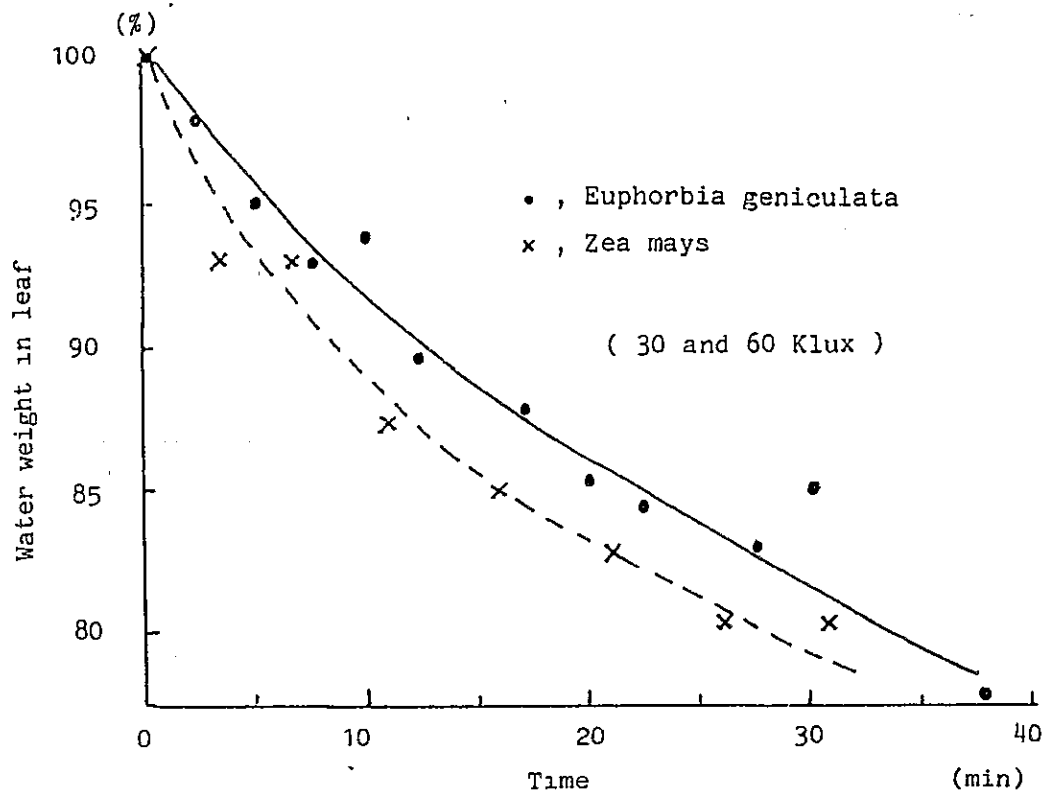


Fig.4 Changes of water content in detached leaf with time under the illumination.

The outline of the experiment 3 and 4

1. Experiment 3

Subject ;

Influences of roots competition on the dry matter production of Zea mays and Euphorbia geniculata.

Purpose ;

In the field condition, the above and underground competition may arise simultaneously with a complicated relationship to each other, so that to examine separately the above and underground competition is considerably difficult. Especially the investigation of roots competition are difficult. Here, as a model experiment, Zea mays and Euphorbia geniculata are grown in mixture in pot where only roots competition may occur, and its effects on the growth are investigated.

Materials and Method;

Zea mays and Euphorbia geniculata, 3 and 20 plants, respectively, were grown in 1-l pots with the same soil property and fertilizing level as in the experiment 1. The experiment plot was consist of the two plots; the mono-culture plot and composite culture plot. Further, the composite culture plot was divided into the two plots of the same time sowing and the different time sowing.

The outline of the method is shown below.

(1) Mono-culture of < Zea mays / Euphorbia geniculata

They are sown on 5th Dec., 1982 and sampled every week from 15th Dec., 1982 to 13th Jan., 1983.

(2) Composite culture (Zea mays + Euphorbia geniculata)

A ; Both plants are sown in mixture in the same pot at the same time.

B ; Both plants are sown in the same pot at the different times.

		Sowing time	Sampling time
A	Same time sowing		
	Zea mays	5th Dec.	30th Dec.
	Euphorbia geniculata		
B	Different time sowing		
	i-1 Euphorbia geniculata	5th Dec.	6th Jan.
	Zea mays	16th Dec.	
	i-2 Euphorbia geniculata	5th Dec.	13th Jan.
	Zea mays	23rd Dec.	
	ii-1 Zea mays	5th Dec.	6th Jan.
	Euphorbia geniculata	16th Dec.	
	ii-2 Zea mays	5th Dec.	13th Jan.
	Euphorbia geniculata	23rd Dec.	

The investigating factors in the experiment 3 are the total dry matter weight, leaf weight, stem weight, root weight, leaf area and other characters.

2. Experiment 4

Subject ;

Observation on the phenomena of competition between Zea mays and Euphorbia geniculata grown in field.

Purpose ;

In order to clarify the competing phenomena developing actually in the field condition, the morphological and ecological changes in the canopy structure and root system with the intensity of competition are investigated periodically.

Materials and Method ;

Zea mays and Euphorbia geniculata were grown in mono-culture and composite culture in the field of Phra Puttabat Experiment Station of DOA on 14th Dec., 1982. The experimental plots were designed as shown in Fig. 1. The canopy structure and relative light intensity in community (aboveground). and root system (underground) were investigated periodically from the early growth stage (no competition) to the late growth stage (intensive competition). The stratified clip method was applied to the survey of canopy structure, and the root system of plants was investigated with the monolith sampler.

Results

As the abnormal low temperation condition in Thailand retarded the growth of material plants, the satisfactory investigation could not be conducted. The experiment should be carried out again by the researchers of NSRI.

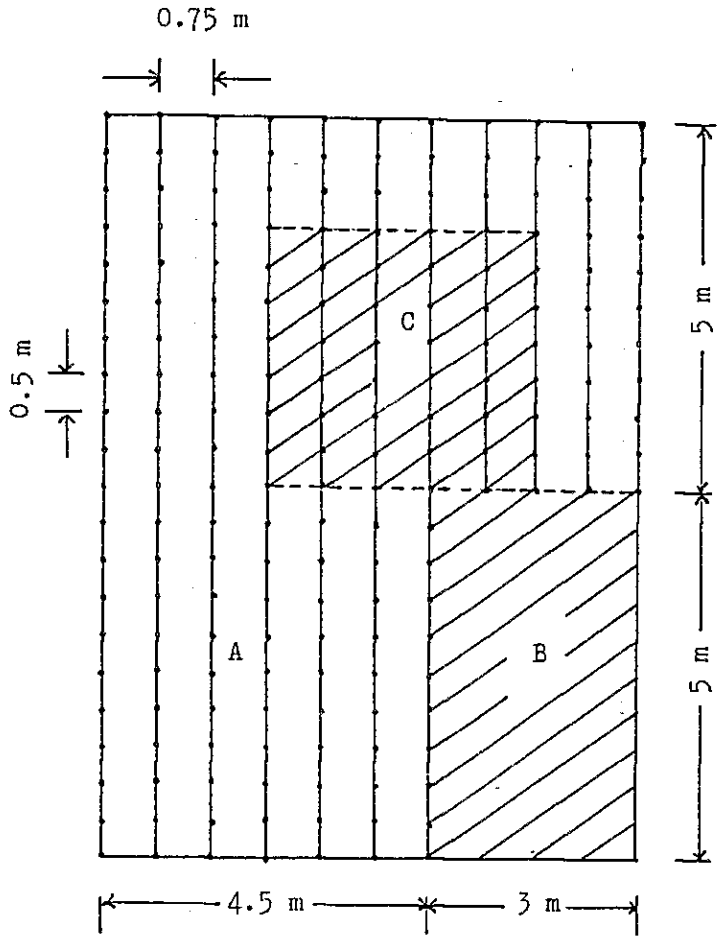


Fig.1 The design of experimental plot.

Notes:

A, the mono-culture of Zea mays ; B, the mono-culture of Euphorbia geniculata ; C, the composite culture of Zea mays and Euphorbia geniculata.

Planting number; 2 or 3 seeds of Zea mays were sown in 0.5 x 0.75 m^2 (thined to a plant / 0.5 x 0.75 m^2), and 200 seeds of Euphorbia geniculata scattered in 1 m^2.

Fertilizing level, a compound chemical fertilizer (N : P_2O_5 : K_2O = 20 : 20 : 0) was applied 30 g to 1 m^2.

Acknowledgements

It has been a great pleasure for me to stay in Thailand and do some cooperative research works with the researchers in National Weed Science Res ··ch Institute Project. I would like to express my sincere appreciation to the Authority of the Department of Agriculture concerned, Mr. Yookti Sarikaphuti, the Director General, Dr. Risk Sayamanonda, the Deputy Director-General, Dr. Tanongchit Wongsiri, the Deputy Director-General, Dr. Umpol Senanarong, the Deputy Director-General and Dr. Winit Changsri, the Division Director, who gave me much arrangement and convenience to do cooperative works.

Further, I would appreciate Mr. Tammong Tanteme, the Director of Phra Puttabat Experiment Station, who kindly permited me to use a part of the field of Experiment Station.

Also I would give heartfelt thanks to Dr. Paitoon Kittipong and all the members of the NWSRI, especially to my counterparts, Miss Maneesa Teerawatsakul and her staff, Mr. Somchart Kanjanajirawong, who not only provided me suitable arrangements and cooperation on experimental works but also made me at home during all over the time of my stay.

To promote my research works effectively, much valuable advice and instruction were given by Dr. K. Noda, the Project Leader, Mr. H. Hyakutake and Dr. H. Shibayama, the Project Experts and Dr. H. Nakamura, the Short Term Expert. I would close this report by expressing a sincere appreciation to these members dispatched from Japan.

中村拓専門家帰国報告書

METHOD OF MEASUREMENT OF PLANT PHOTOSYNTHESIS AND DETERMINATION OF ATP BY LUCIFERIN-LUCIFERASE METHOD

HIROSHI NAKAMURA *

February 8th, 1983

* Chief of Weed Control Laboratory

Tohoku National Agricultural Experiment Station (Japan)

My stay at this institute will terminate on February 9th. Before my departure for my country I would submit herewith a very brief report on my assignment requested by this project and experiments which I have carried out with my counterpart during two months.

My stay in this institute was very short, but it was one of the most pleasant and useful experience for me. I would express my sincere appreciation to Mr. Yookti Sarikaphuti, the Director General, Dr. Tanongchit Wongsiri, the Deputy Director General, Dr. Risk Sayamanonda, the Deputy Director General, Dr. Umpol Senanarong, the Deputy Director General and Dr. Winit Changsri, the Division Director, for much arrangements and cooperation to do my works.

I would acknowledge Dr. Paitoon Kittipong, the Chief of Weed Science Group, Miss Maneesa Teerawatsakul, the Chief of Weed Control Group and all the members of NWSRI for their much help and arrangements. I would like to thank Mrs. Cha-um Premasthira, my counterpart, for her zealous cooperation and much help.

Further I am indebted to Dr. Kenji Noda, the Project leader, Mr. H. Hyakutake, Dr. H. Shibayama and Dr. F. Kubota, the Project experts, for their guidance and much help.

Measurement of photosynthesis using infrared gas analizer

Many herbicides affect photosynthesis. It is, therefore, useful to investigate the effects of herbicides on photosynthesis for studies on mode of action of herbicides. Further the recognition of importance of photosynthesis has recently grown since it was found that photosynthetic rate per unit leaf area varied many fold among species and such differences are closely associated with the different path way in dark reactions of photosynthesis. That is, plants having chlorophyllous bundle sheath around the vascular bundles in leaf take C-4 path way and plants lacking chlorphyll in such organ take C-3 path way. It is considered that such difference may have an important action in competition between crops and weeds. There are a lot of C-4 plants in tropical regions including Thailand. Many interesting informations on competition will be obtained through investigation on photosynthesis of those plants. Then, we started at first to construct a measuring system for photosynthesis in intact plants.

1. Construction of apparatuses for measurement of photosynthesis using the infrared gas analyzer, Model ASSA-1110, HORIBA LTD.

A lot of apparatuses and instruments are necessary to measure photosynthesis. At first we constructed the system as illustrated in Fig. 1 with the help of assosiate workers.

1) Assimilation chamber

Two types of assimilation chamber were prepared (Fig.2). One was for intact plant and the other was for single leaf. They were made of transparent acryl resin and a small fan was equipped inside of the chamber to stir the air in it.

2) Air flow system

We used natural air for measurement, but as shown Fig. 3, concentration of CO_2 in natural air fluctuated even if it was taken at the roof of institute building. Therefore, we made an air reservoir of vinyl film (1.7 x 1.7 x 1.7 M^3). Using this reservoir we could supply a constant concentration of CO_2.

3) Illumination

Illumination was made from above with the Sun light lamp made in Toshiba Co.,Ltd.

2. Actual measurement of photosynthesis

We carried out an experiment to obtain light curve on corn and Euphorbia geniculata which is one of the most harmful and widely spreaded weeds in corn fields and was estimeted to be a C-3 plant by from an anatomical point at the same time in the cooperative work of NWSRI Project.

Materials and Method

1) Plant; Corn and E. geniculata seedlings of about 30 cm tall were used.
2) Illumination; Light intensity was changed from high to low and measured by an illimination meter (Topcon SPI-71 Tokyo KogaKu KiKai Ltd) at leaf position.
4) Air flow rate; Air flow rate was regulated to 120-150 l/hr.
5) Temperature; Temperature in the chamber was kept about 30 C.

As shown Fig. 4, we got an expected result of experiment on photosynthesic rate per unit leaf area of both plants, that is, the light curve of corn (C-4 plant) showed higher value than that of E. geniculata (C-3 plant).

As it is observed by Dr. Moda and Mrs. Chanpen that there are some C-4 type species in Euphorbia, it is expected to obtain many interesting and important informations on their photosybthesis by using this system.

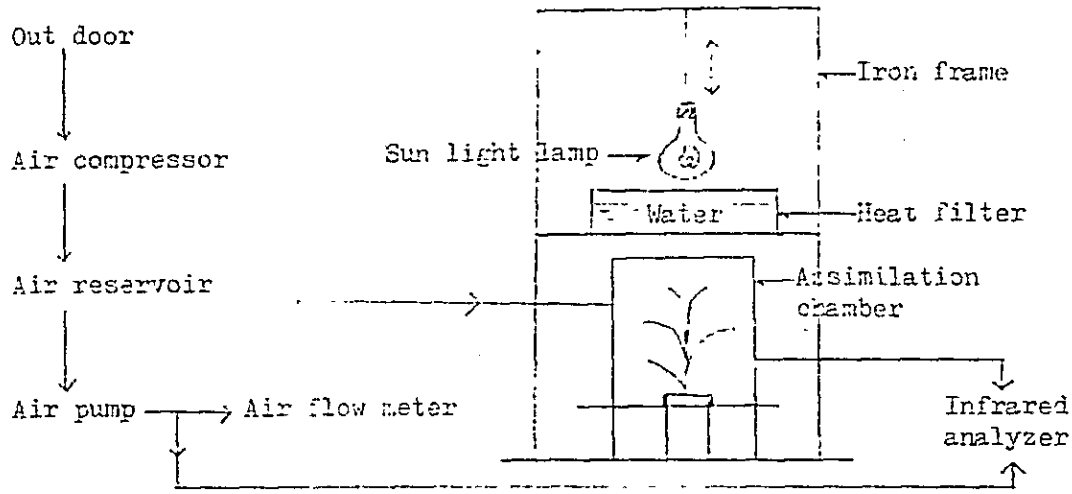


Fig 1. Flow chart of the system for measurement of photosynthesis.

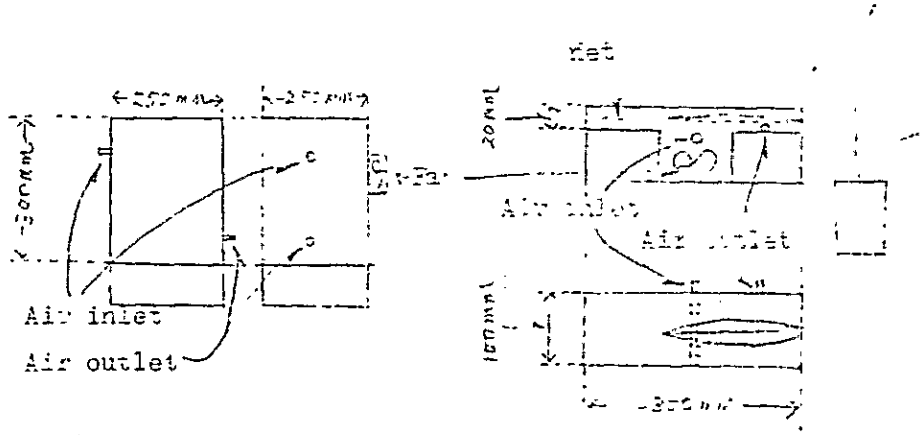


Fig 2. Assimilation chamber made of acryl resin; Left for intact plant, Right for single leaf.

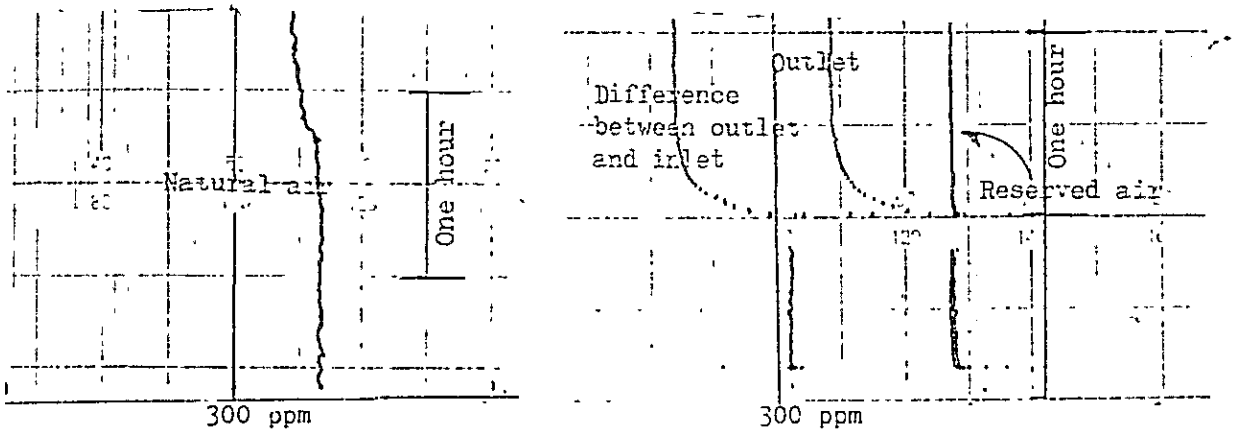


Fig 3 Fluctuation of CO concentration in natural air and reserved air.

(one division 0.6 ppm)

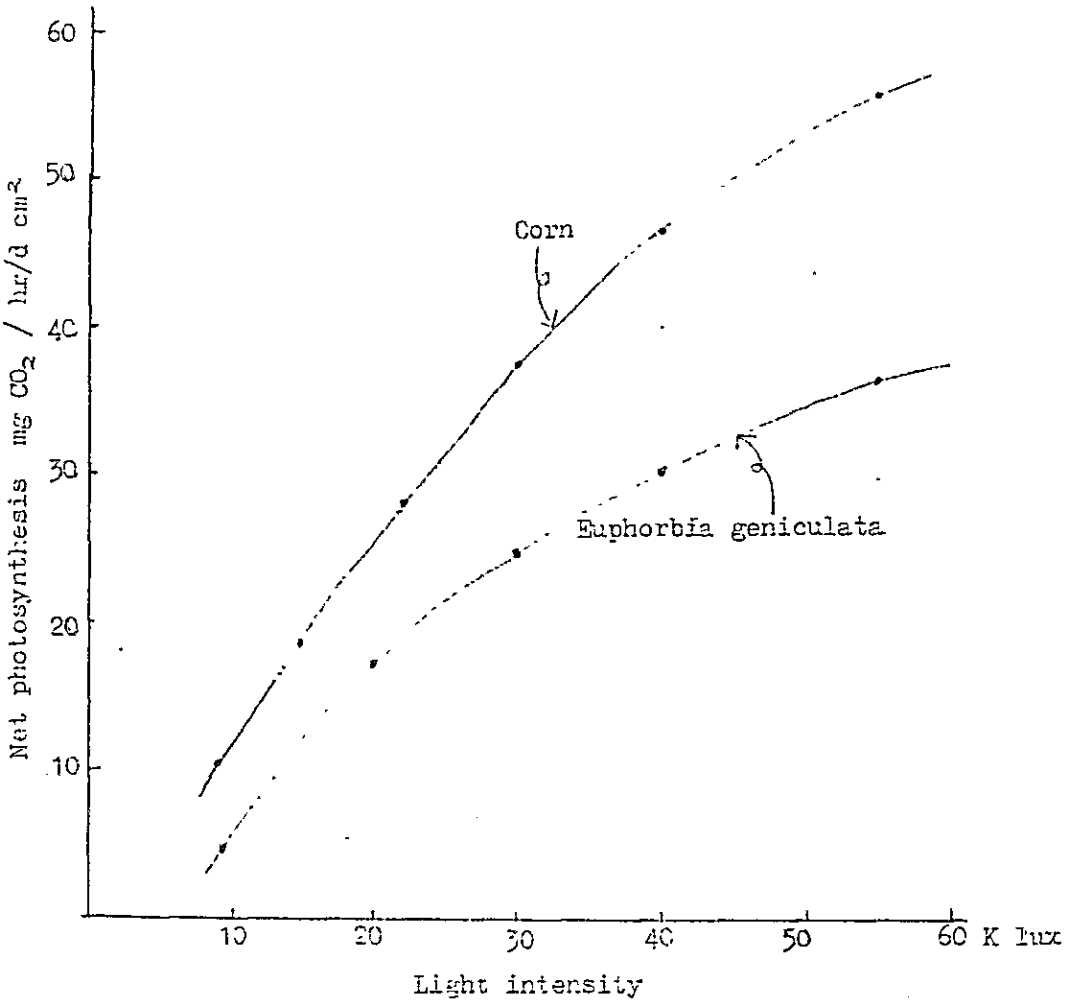


Fig 4 Light curves of corn and Euphorbia geniculata

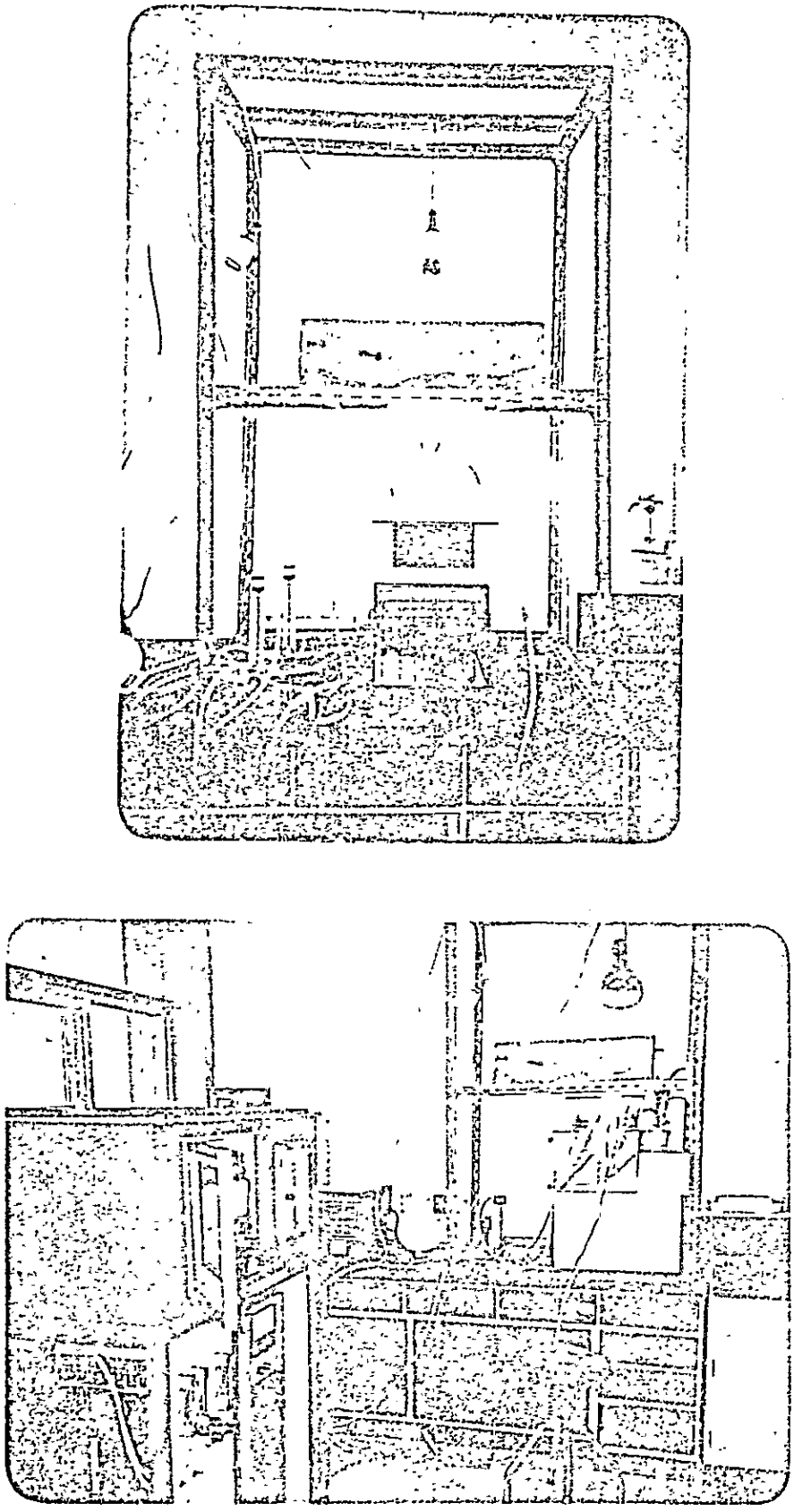


Fig. General view of photosynthesis measurement ; Above for intact plant, below for single leaf.

Determination of ATP by luciferin-luciferase method

ATP is required for many important biochemical reactions as energy source. Especially germinating seeds require a tremendous supply of ATP for the biosynthesis and biochemical work. It is, therefore, of interest to measure ATP during germination as an index of seed activity. A principle of the lucifering-luciferase method is described as foolows :

$$\text{Luciferin} + \text{ATP} \xrightarrow{\text{Luciferase}} \text{Emission of Fluorescence}$$

In above reaction, intensity of fluorescence is in propotion to ATP quantity. thus ATP is determined by measurement of fluorescence using a photometer.

The experiment was carried out in an attempt to learn more the effect of Acifluorfen sodium, (Blazer) on germination of Chloris bartata (monocotyledon plant) and Euphorbia geniculata (dicotyledon plant) by measurement of ATP content in germinating seedlings and method of ATP determination.

Materials and Methods

50 seeds each of Chloris batata and Euphorbia geniculata were germinated in Petri-dishes in room temperature for 4 days under fifferent concentration of Acifluorfen solution. Concentrations used were 0.1, 1, 10, 100 ppm.

ATP was extracted by boiling buffer, seedlings were quickly dropped in 20 ml of boiling pH 7.8, 0.1 M, trisbuffer and extracted for 10 minutes. The extract was cooled in an ice bath.

ATP was determined by the luciferin-luciferase method. The light emission was determined by Aminco Chem-Glow photometer after adding 0,25 ml

of firefly lantern extract (Sigma FLD-50) to 0.25 ml of the extract. ATP concentration in the extract was calculated by the formula made from standard solution.

Result

A good correlation was obtained between concentration of standard ATP solution and light intensity in log-log scale (Fig. 5).

The contents of ATP in seedlings increased in proportion to germination rate and growth of seedlings except in 100 ppm of Chloris bartata, as shown table 1.

It is necessary to determine ATP content in an earlier stage of germination in order to learn the effects of herbicide on germination of both plants.

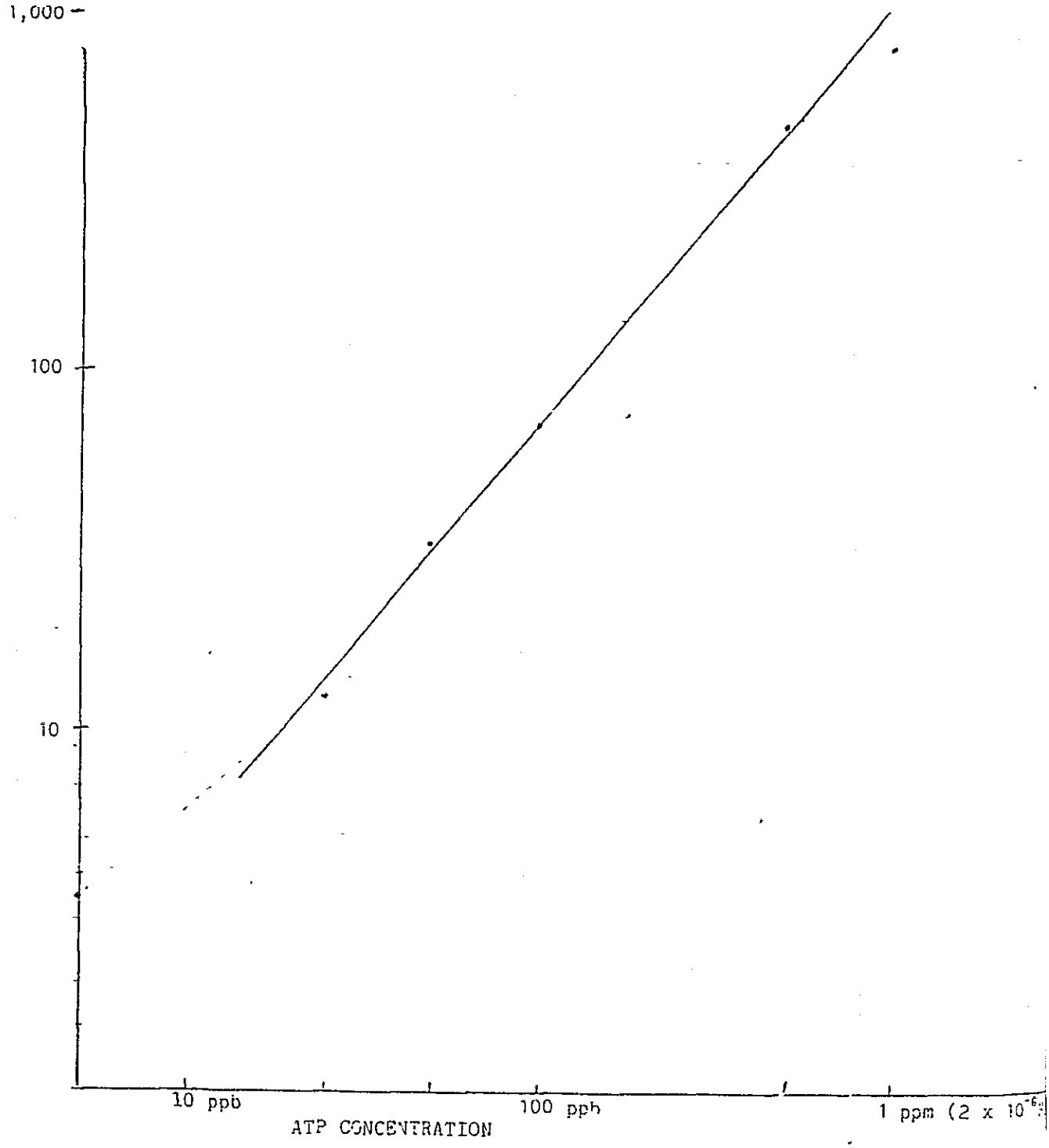


Fig 6 Calibration curve for determination of ATP

Table I. Effects of Acifluorfen on Germination and ATP Content of Euphorbia geniculata and Chloris batata

Plant	Concentration	Germination rate	Growth of seedling (m.m)		ATP Content
			leaf	root	
Euphorbia geniculata	Control	19	2.1	3.88	$2x10^{-6}$ g/seed
	0.1 PPM	17	1.72	3.12	$2.2x10^{-6}$g/seed
	1 PPM	18	1.96	2.88	$1.2x10^{-6}$g/seed
	10 PPM	12	1.32	2.32	$7.2x10^{-8}$g/seed
	100 PPM	14	0.56	1.46	$1.4x10^{-8}$g/seed
Chloris bartata	Control	18	0.34	-	$4x10^{-8}$g/seed
	0.1 PPM	17	0.95	0.8	$1.1x10^{-8}$g/seed
	1 PPM	10	1.02	1.13	$1x10^{-8}$g/seed
	10 PPM	0	0	0	$6.8x10^{-9}$g/seed
	100 PPM	6	-	-	$1.6x1-^{-8}$g/seed

山田忠男専門家帰国報告書

June 2, 1983

Report on Study Work

by Short-term Expert of JICA

National Weed Science Research Institute (NWSRI)

Project in Thailand

Herbicide Residue Problems and the Chemical Analyses

Tadao YAMADA

Senior Researcher

Pesticide Division

National Institute of Agricultural Sciences

Tsukuba, Japan

My schedule in NWSRI (April 7 to June 6, 1983) is now closing. Before my departure for my country I would submit herewith a brief report on my study works which I have carried out with my counterpart and many staffs during two months.

My stay in this institute was very short, but it was one of the most pleasant and fruitful experience for me. I would like to express my thanks to Mr. Yookti Sarikaphuti, the Director-General, Dr. Tanongchit Wongsiri, the Deputy Director-General, Dr. Riksh Syamananda, the Deputy Director-General, Dr. Umpol Senanarong, the Deputy Director-General, and Mr. Visut Chandrangsu, the Director of Division for much arrangements to do my works.

I would acknowledge to Dr. Paitoon Kittipong, the Chief of NWSRI, and all the members of NWSRI for their much assistance and arrangements. I am very grateful to Dr. Prateep Krasaesindhu, my counterpart, and Mrs. Chanya Maneechote, my assistant for their zealous cooperation and much help.

Further I am indebted to Dr. Kenji Noda, the Project leader, Mr. Hiroshi Hyakutake and Mr. Kiyoshi Kojima, the Project Experts, and their secretaries for their guidance and much help.

Main Schedules

April	7 (Thur)	Arrival to Bangkok
	7-16	Cooperation with JICA team (leader, Dr. Kusanagi)
	13-14	Tour to Huahin district
	25	Attendance to DOA seminar
May	2	NWSRI seminar report (1)
	12-14	Tour to Chiang Mai Province
	16	NWSRI seminar report (2)
	26-27	Tour to Ravong Province
	30	NWSRI seminar report (3)
June	3	Report to DOA and JICA office
	6 (Mon)	Leave Bangkok

During this months, experiments and discussions on a new analytical method of paraquat and diquat residue by gas chromatography have been earnestly done.

Visit to Institutions

I visited many institutions and discussed our common interests. The main institutions as follows :

Divisions of DOA (Agricultural Chemistry, Agricultural Toxicology, Plant Pathology, Soil Science, Agricultural Regulatory)

Inland Fisheries Institute

Chiang Mai University

Kasetsart University, Sri Racha Student Training Center

Maejoe Institute of Agricultural Technology

Sanpatong Rice Experiment Station

Chiang Mai Field Crop Research Center

Huoy Pong Field Crop Experiment Station

Land Development Center (Samphran)

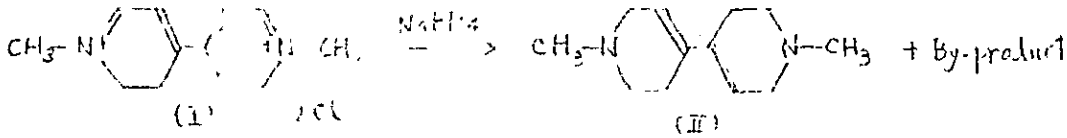
Plantations of tea, Mango, Lychee, Longan, Durian, Mangostin, Pineapple, Sugarcane, Cassava and Rubber

NWSRI seminar reports

In the first seminar, as a case study of herbicide residue, studies on the rice-plant dwarfing caused with metabolite of thiobencarb (benthiocarb) were reported showing many slides. In the second, recent problems on chlornitrofen (CNP) residue were reported. In the third, our studies on the residue problems of paraquat, and analytical method of paraquat and diquat were summarized. In each seminar, many audiences including other divisions attended and earnestly discussed.

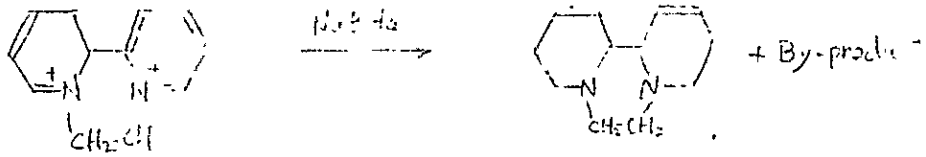
Analytical method of paraquat residue

In Thailand, use of paraquat is increasing recent years as shown in Fig. 1. On the other hand, it is suspected as a cause of death of fresh water fishes. The paraquat residues in water, soil, and biotic samples are usually analysed by absorption spectral methods following the laborious extraction and cleanup process. We tried to establish a new analytical method using gas chromatograph (GC) which is developing as a high sensitive instrument. Paraquat itself is not analyzed by GC because of non volatile. It is necessary to derivatize to the volatile compound before GC. According to Ukai et al. (1973) and King (1979) reports, we tried to derivatize paraquat (I) to the reduction-product (II) with $NaBH_4$. In the same manner, diquat (III) to the



(I)

(II)



(III)

(IV)

reduction-product (IV). FTD (Flame thermionic detector) was used as a detector of GC, because of high sensitivity to nitrogen compounds.

(a) Reduction of paraquat and diquat with $NaBH_4$

According to the Ukai report (1973), 2 ml of paraquat dichloride aq. solution (1-100 ppm) was pipetted into a test tube, added with 1 ml of 1% $NaBH_4$ aq. solution, and shaken for a while. After standing for 30 min in room temperature, the aqueous solution was vigorously shaken with 2 ml of benzene. 5 µl of the upper benzene layer was injected to GC. The same

method was applied to diquat dibromide.

(b) Gas chromatography of the reduction-product

The following glass columns were tested :

2% OV-1, 3.1 m (160 C - 240°C), 5% DC-11, 2.1 m (220°C)

2% OV-17, 2.1 m (220 C), 2% EGA, 2.1 m (200°C)

2% QF-1, 2.1 m (160 C - 220° C)

2% DEGS + 0.5% H_3PO_4, 2.1 m (210°C)

No favorable column for the paraquat reduction-product was found, but, 2% OV-1 and 2% OV-17 were relatively permissible. Then, the following GC conditions with 2% OV-1 were tentatively established.

GC conditions

Shimadzu GC-7A with FTD

Column : glass 3 mm x 3.1 m, packed with 2% Silicone OV-1 / Chromosorb W (AW-DMCS) 80-100 mesh

Carrier gas : N_2 60 ml/min

H_2 : 3 ml/min (0.65 kg/cm^2)

Air : 150 ml/min (0.5 kg/cm^2)

Temperature : column 220 C, injection port = detector 250°C

Power : 7.5 - 7.8 V (20% fs at attenuation 256)

Range : 1

Attenuation : 64-1026

Retension time (min)

Paraquat reduction-product	1.5 - 1.6	(by-product 1.2)
Diquat reduction-product	1.2	(by-product)
Thiobencarb (benthiocarb)	ca 3.0	
Chlornitrofen (CNP)	ca 8.1	

Calibration carve

Benthiocarb was linear in the range of 1-200 ng. In case of paraquat, the peak height was not linear, but in the lower injection, was very low or disappeared. Diquat was intermediate (Fig. 2).

(c) Determination of paraquat in water

The higher concentrations of paraquat (10-100 ppm) are easily determined by test-tube method (a). To determine the lower concentrations of paraquat (0.01 -10 ppm), 100 ml aq. solution was treated by using a separatory funnel (200 ml). The paraquat in water was reduced with 0.1 g of $NaBH_4$ (addition of 1 ml of 10% aq. solution), and extracted with 20 ml of benzene. The benzene layer was hydrated with $NaSO_4$, and an aliquot was concentrated by evaporation. The results of GC determination are summarized in Fig. 3. Addition of 0.01 g of $NaBH_4$ resulted in lower peaks.

A water sample from field (99 ml) was fortified with 1 ml of paraquat dichloride stock solutions to 0.1 ppm and 1.0 ppm. 0.01 g, 0.1 g and 1 g of $NaBH_4$ was added. After standing for 2hrs, the reduction-product was extracted with 20 ml of benzene, dehydrated and concentrated.

Results of these experiments reveals that even when distilled water used, paraquat in lower concentrations was difficult to detect. Increasing addition of $NaBH_4$ to field water improved the detection of paraquat.

(d) Remaining problems

To accomplish a new analytical method, many problems must be dissolved. Our study during two months, was too short to dissolve these problems. The remaining problems are listed here :

1) Obtaining the favorable column for paraquat reduction-product

2) Effective reduction conditions

3) Many problems on analysis of field samples

4) Comparison with spectrophotometric methods

Further studies to accomplish the analytical method will be done in cooperation with Japanese researchers.

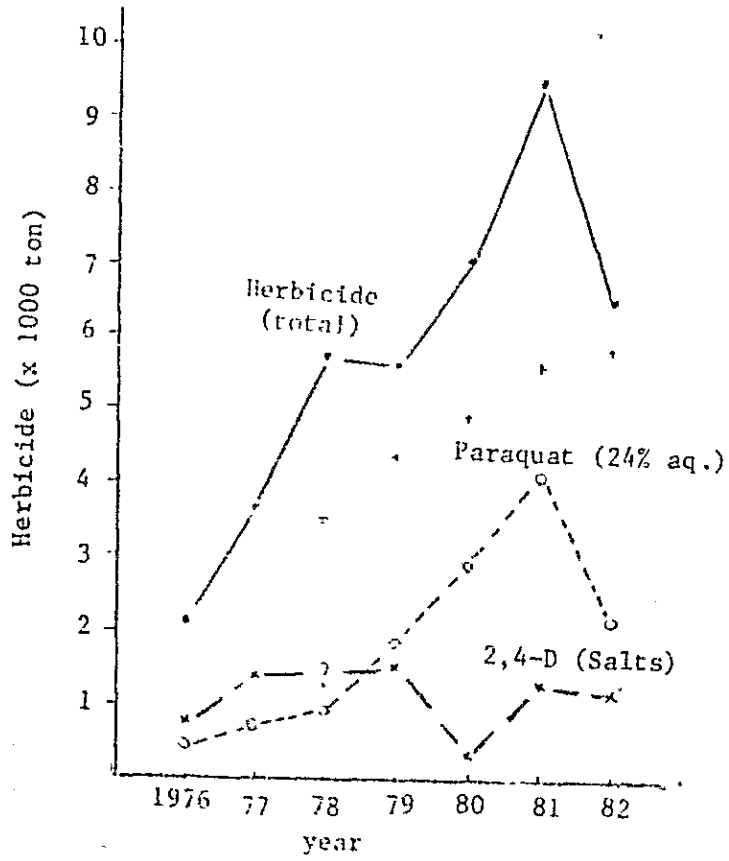


Fig.1 Imported herbicides in Thailand
(Data from Agricultural Regulatory Division)
+ mark shows paraquat used in Japan

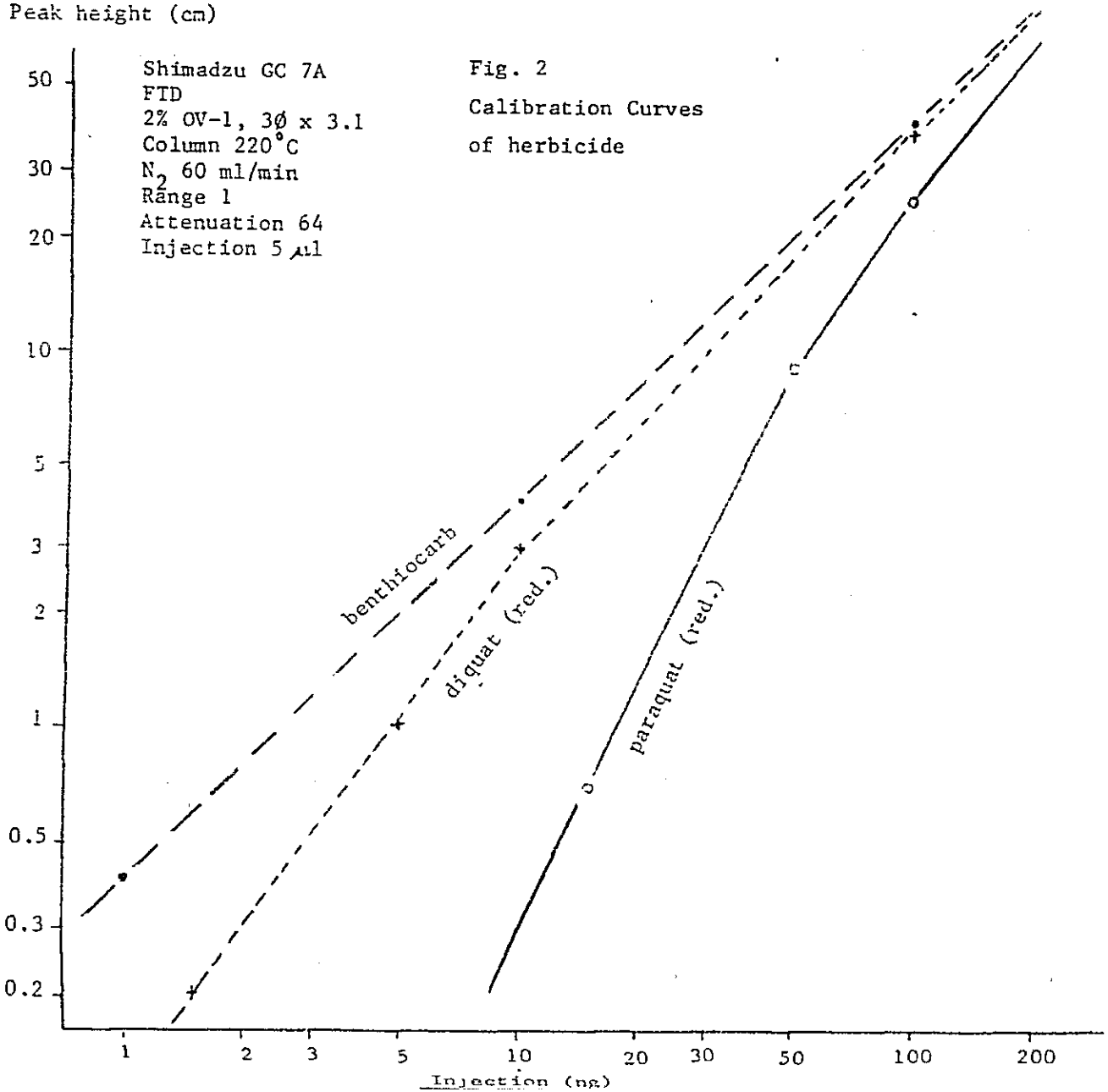


Fig. 2
Calibration Curves
of herbicide

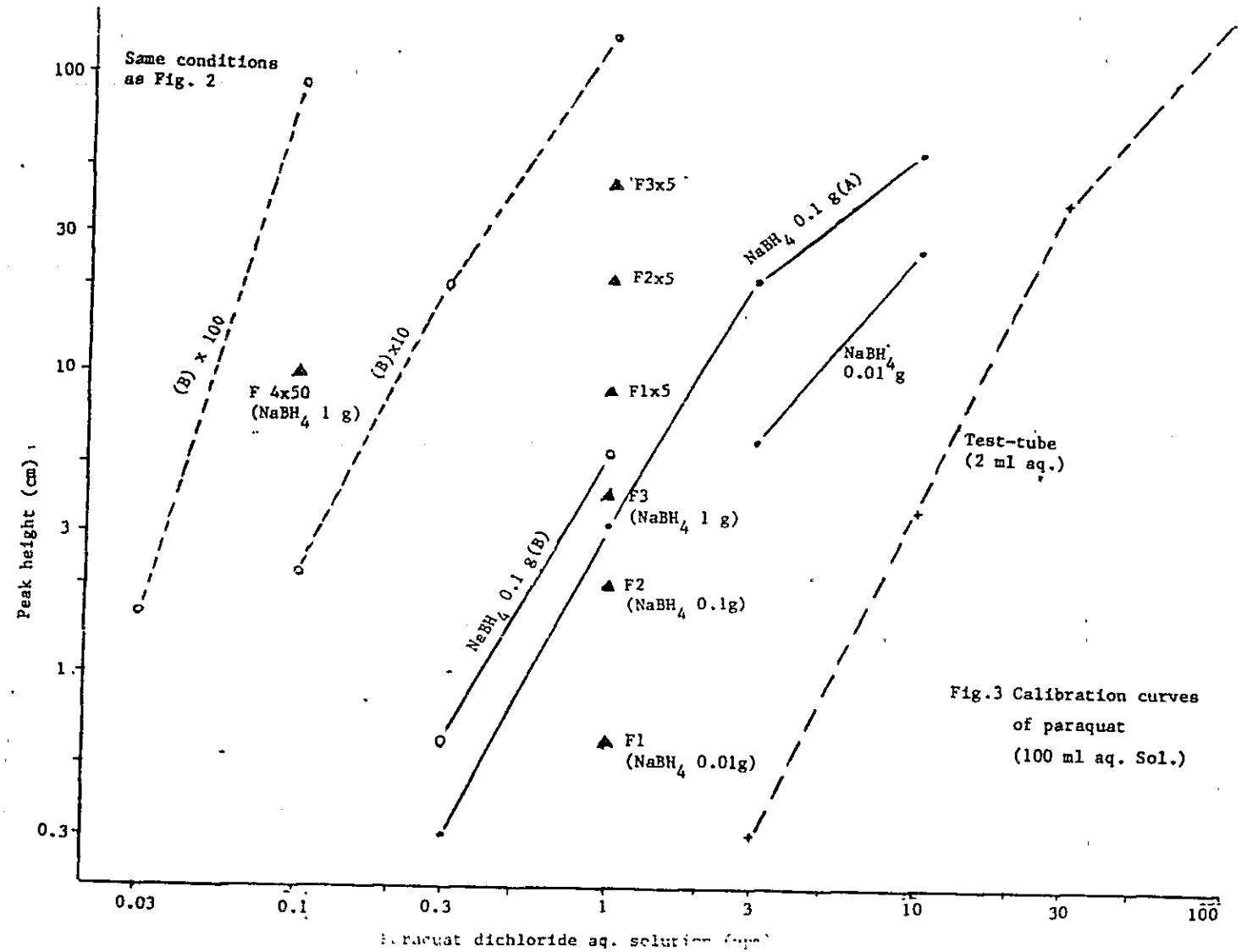


Fig.3 Calibration curves of paraquat (100 ml aq. Sol.)

坂斉専門家帰国報告書

ON STUDY WORK OF PHYSIOLOGIACL AND BIOCHEMICAL BASIS FOR THE DETECTION OF SELECTIVE HERBICIDE ACTION

Hitoshi SAKA

Short-term expert of JICA in
National Weed Science Research Institute
(NWSRI) Project in Thailand

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Plant Physiology Division
National Institute of Agricultural Sciences
Tsukuba, Japan

31th August, 1983

Contents

Preface

These experimental study works were performed through the closed co-operative relationships with all NWSRI staffs, especially two excellent researchers, Mrs. Cha-um Premasthira and Miss Siriporn Zungsontiporn.

We everytime discussed on the experiments in detail each other. Repeatness of these discussions and experiments gave us good experimental results, I believe.

My stay in NWSRI was too short to do enough research work. I hope the coming new "short-term" expert in JICA from Japan should stay and work at least 4 to 6 months here.

30th August, 1983

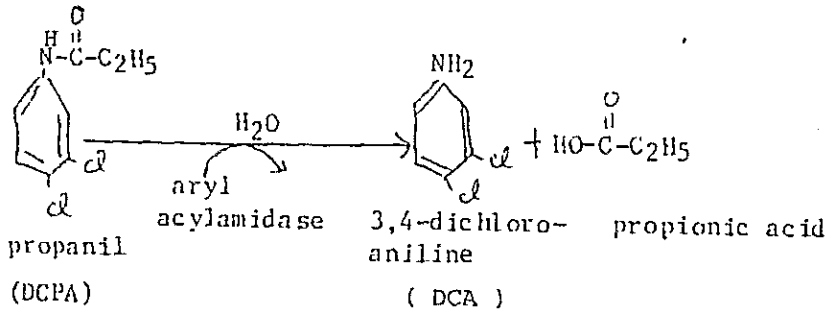
Physiological and Biochemical Basis for the Detection of Selective Herbicide actions

The elucidations of the mode of action and the selective action of herbicides in plants are very important and useful for not only weed control fields and developments of new herbicides, but also physiological and biochemical basis of plant growth regulation as specific metabolic inhibitors.

In this experiment, handling methods for herbicide catalyzing enzyme activity and one of assay methods for identification and its activity-detection of herbicides were investigated.

I. Propanil hydrolyzing enzyme assay

Propanil (3,4-dichloropropionanilide) can be used in post-emergence foliar applications as a selective herbicide for the control of barnyardgrass and other annual weeds in the rice field. Because propanil is rapidly hydrolyzed to untoxic compounds (3,4-dichloro-aniline-DCA-, and propionic acid) in the rice seedlings, but not in barnyard grass and so on.



This propanil hydrolyzing enzyme (aryl acylamidase I) activity is quantitatively measured by color reaction intensity of DCA released from enzyme reaction.

Materials and Methods

Seven day-old seedlings of Indica type domestic local rice varieties and wild rices (Oryzae, but not identified) were used in this experiment.

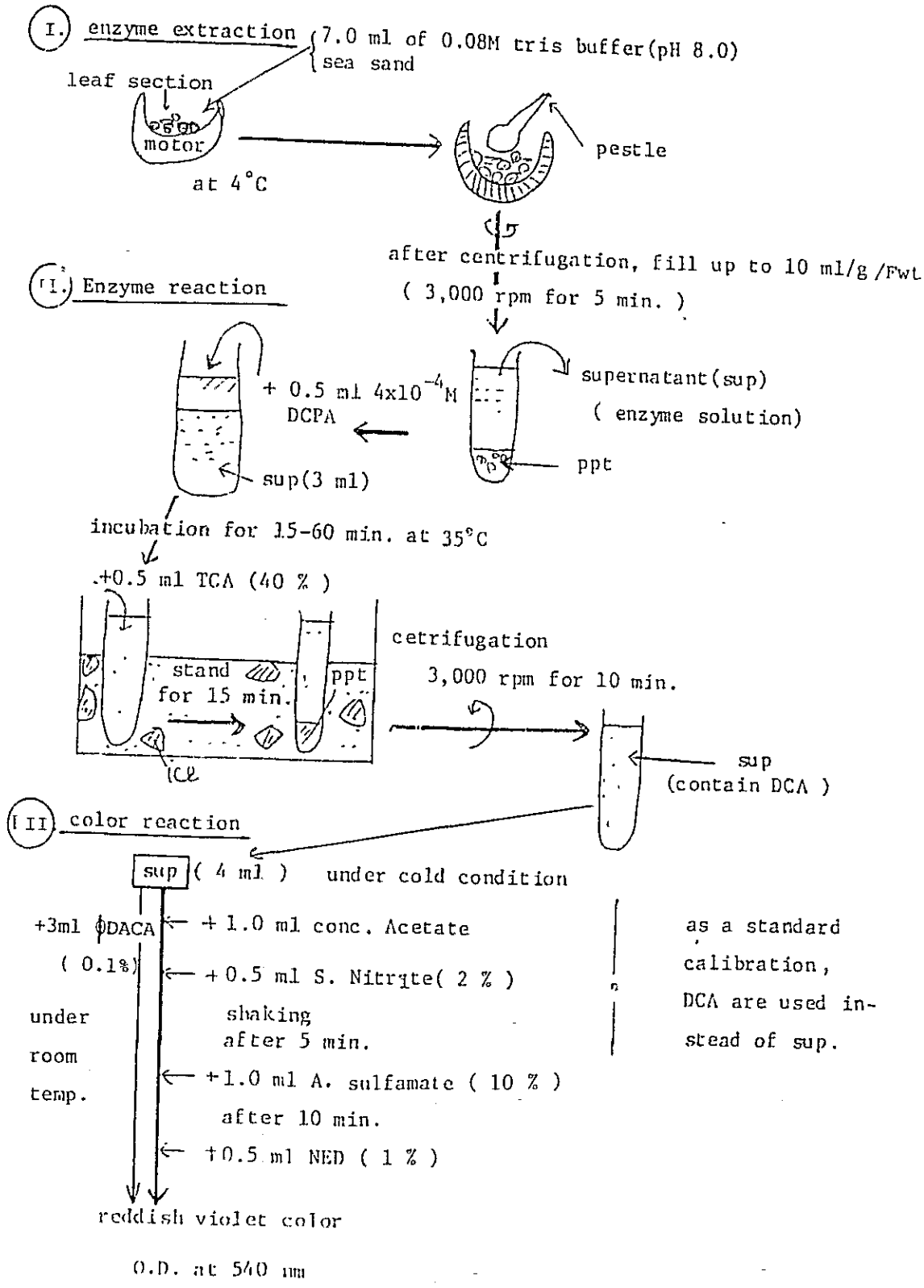
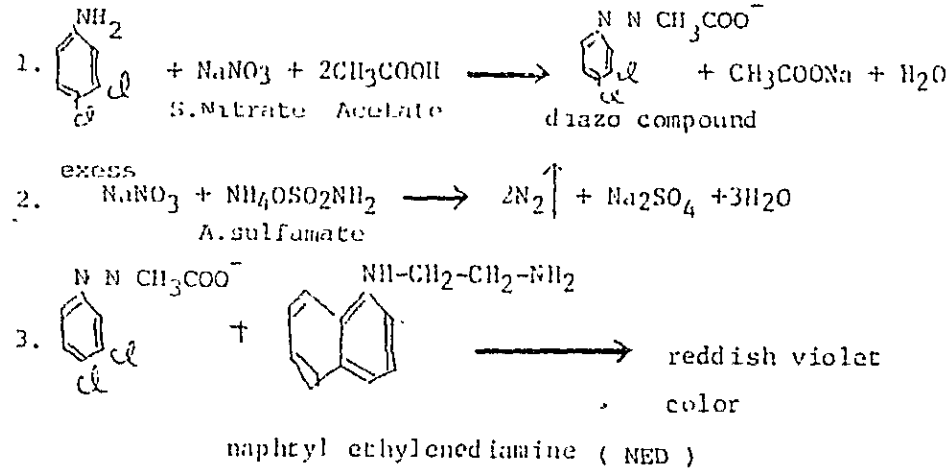


Fig.1. Procedures for enzyme extractions and 2-ways color reaction by ϕ-DACA and NED

I. color reaction by diazo coupling of DCA (NED)



II. Color reaction of DCA with O-dimethylaminocinnamaldehyde(O-DACA)

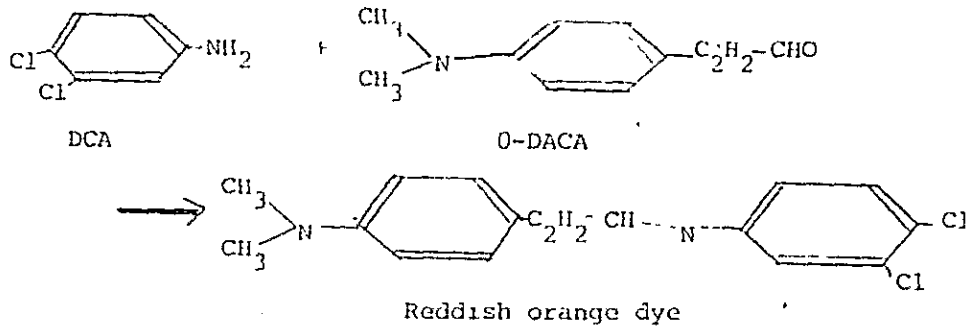


Fig. 2. Chemical color reaction of DCA formed from enzyme reaction with Ø-DACA and NED

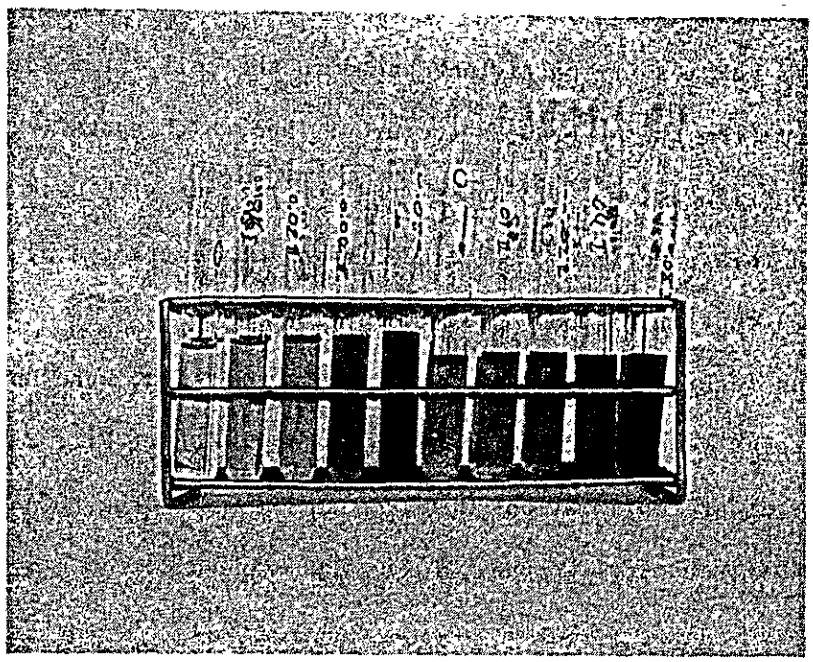


Fig. 3. Color reaction of DCA for standard calibration curve

Violet color : color reaction of DCA-diazocoupling compound with NED. Left to right(DCA-nmole); 0,10,20,40,80.

Reddish-orange color: color reaction of DCA with pDACA. Left to right(DCA-nmole): 0,10,20,40,80.

The plants were cultured by Appendix III (at page iv).

Enzyme assay systems were consisted of 3 step-processes, that is, enzyme extraction, enzyme reaction and determination of intermediate-product (DCA) from enzyme reaction by color reaction. These processes were illustrated in Fig. 1.

As this enzymes are particle-bounded in the cell, it is difficult to separate them from the membrane structures. Then, high speed (10,000 rpm or more) centrifugation will result the supernatant with weak enzyme activity. In this experiment, the crude enzyme was extracted by low speed (3,500 rpm) centrifugation.

DCA, an intermediate product from enzyme reaction, were applied to 2-kinds of color reaction systems to compare each other(Fig. 2).

As a standard calibration curve, pure chemical drug, DCA (purchased from Tokyo Kasei chemical Company, Tokyo) were used.

Results and discussions

Propanil hydrolyzyng enzyme activities were calculated from color reaction, quantitative DCA contents released from enzyme reaction, that is, nmole DCA/ g Fresh wt.leaf/ hr. Action spectrum (Fig. 4) and color intensity at 540 nm after the reaction of DCA with NED (Fig. 3, left side) or with β-DACA (Fig. 3, right side) were preliminary compared (Fig. 5).

Action spectrum of each color reaction has almost same maximal optical density (O.D.) at 540 nm, but the peak of DCA-β-DACA color reaction was more sharp than DCA-NED's.

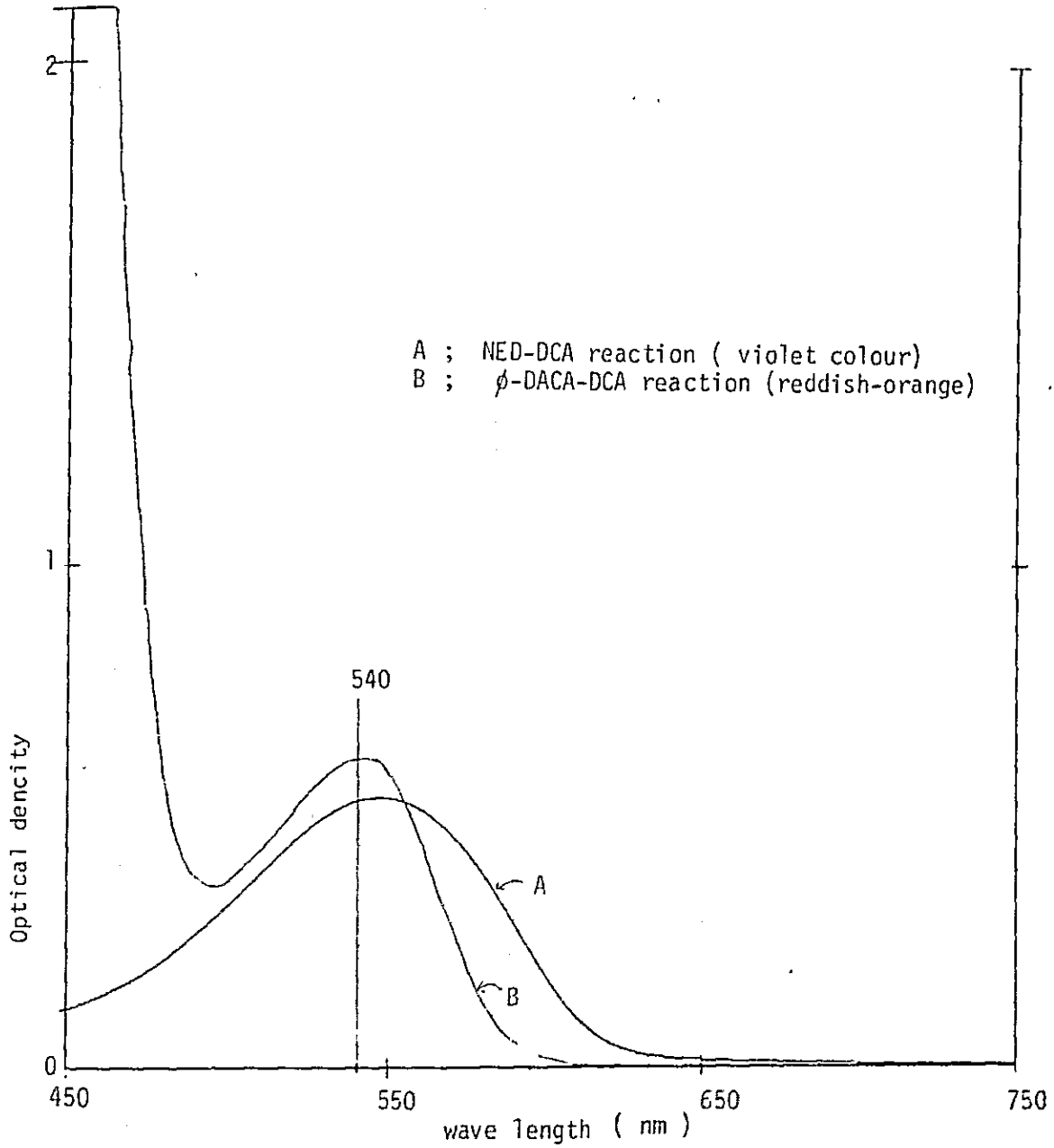


Fig. 4 Spectrum of color dye compound of DCA with NED and ϕ- DACA

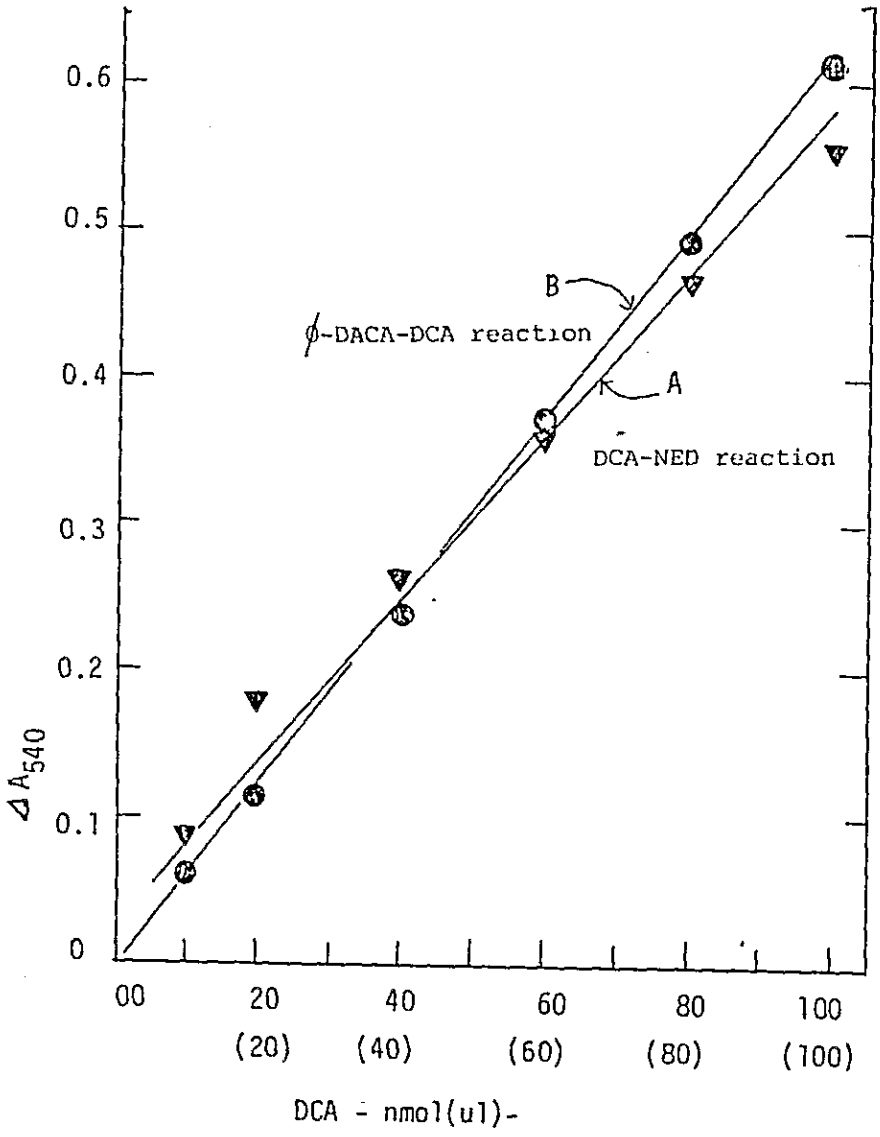


Fig. 5 Standard curve for calibration of DCA by color reaction. Refer the picture in Fig. 3.

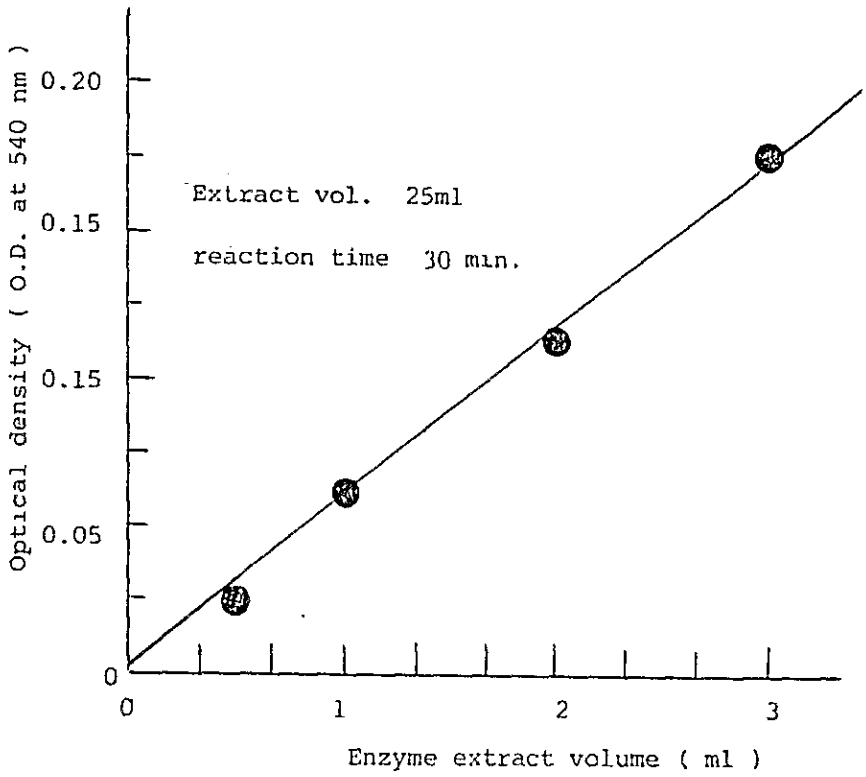


Fig.6. Relationship between extract volume and enzyme activity.

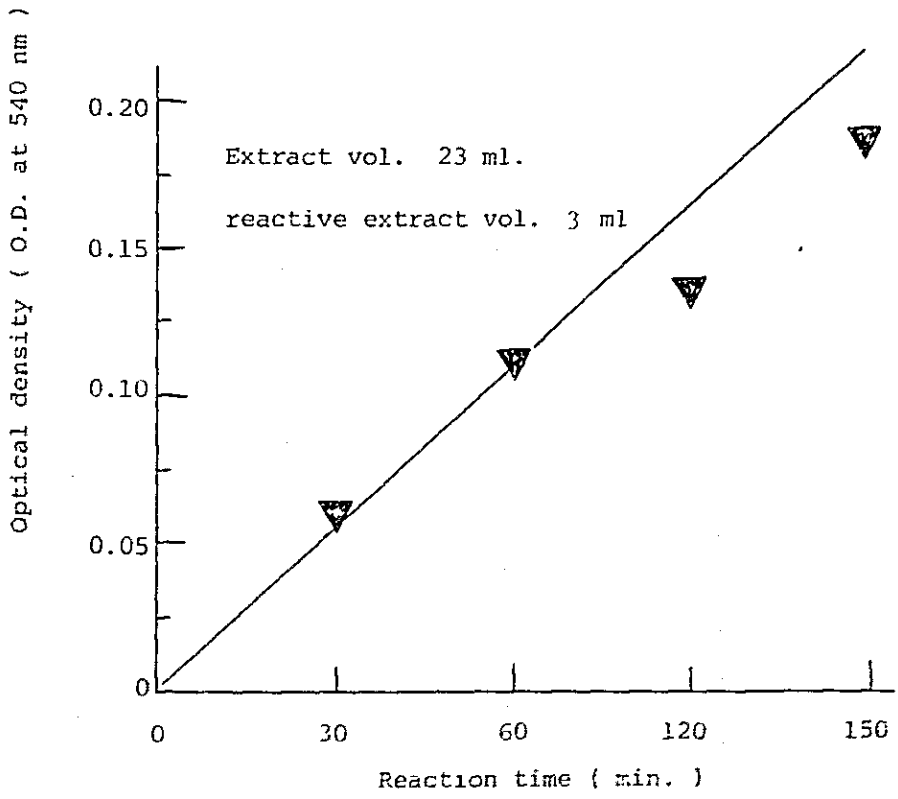


Fig. 7 Relationship between reaction time and enzyme activity

In this experiment, We chose the DCA- ϕ-DACA color reaction with more simple steps than DCA-NED's to detect propanil hydrolyzing enzyme assay.

Next, extract volume (3ml) and reaction time (30 min.) were decided by the preliminary experiments on the relationship between extract volume and enzyme activity and between reaction time and enzyme activity (Fig. 6,7). In in vitro reaction, enzyme also has at least pH dependency (in this case, pH 8.0) and temperature dependency (in this case, 35°C). Then, after confirmation of these pH and temperature dependency as well as reaction volume and times, enzyme activity should be measured under the optimal reaction conditions.

Table 1 shows the propanil hydrolase activity in the seedlings of local rice varieties and wild rice. The comparison of each variety by specific activity (nmole DCA/ mg soluble protein/ hr) should be done in next time, but both of local varieties and wi ld rices have big varietal differences, so far, about 10 nmole in lowest one and about 30 or more in highest.

Rice field in thailand have big problems by the spread of some kinds of wild rices. The results shown Table 1 indicate that these wild rice cannot be controled by propanil.

So far, the contaminations of wild rices in the rice field, can be controled by mechanically.

Table 1. Propanil hydrolase activity in the seedlings of local Indica varieties and wild rices(Oryzae)

Varieties	Activity(nmol DCA/ g f wt/hr)
Experiment I (wild rice)	
Type I in Raj-buri	22.6
Type 2 in Sing buri	22.7
Type 3 in South area	24.5
Type 4 in Sara buri	10.4
Type 5 in Pitsanuloke	35.6
Type 6 in Army camp, Sara buri	20.3
Khoa dok mali (cultivated var.)	35.6
Experiment II (Domestic local variety)	
1. Leug pra tew	11.7
2. Leb mue Nahng	15.7
3. Nahng mon S-4	14.3
4. Ta poa Kaew	25.4
5. Nahume praya	31.9
6. Khoa dok mali	20.4

Experiments were performed in dependent on Material and methods

Enzyme reaction time : 30 min.

II. Simple Bioassay of Auxin-Mediated bio-regulators by Lamina Joint Method

Lamina joint is the connecting point between lamina and sheath of rice plant leaf. This joint have several hundred cells sensitive to auxin at young seedling stage in the abaxial side of shoot.

The auxin-sensitive property of lamina joint cells gives the simple bioassay system for detecting auxin-mediated promootive and inhibitive compounds to us.

This physiological assay method is simpler and more facile than other systems, that is, Avena curvature test (auxin-mediated) straight growth test in avena first internode section (auxin-mediated), Raphanus test (cytokinin-mediated), soybean and/or tobacco callus growth test (cytokinin-mediated) and GA_3-dependent α-amylase assay in barley and /or rice half seeds (GA_3-mediated).

In this experiment, herbicide actions to auxin-mediated lamina inclination (correspond to " cell elongation ") of lamina joint system were investigated after some preliminary tests on this assay method.

Materils and Methods

Some loval Indica rice varieties and one Japonica rice (Norin-no.8) variety as a check were used in this experiment.

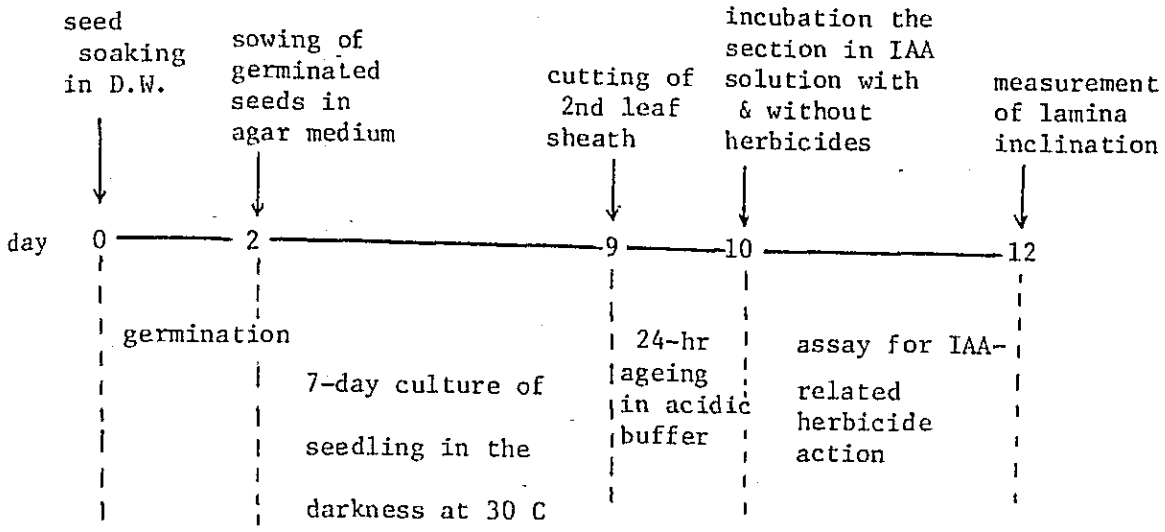


Fig 8. Lamina inclination test procedure

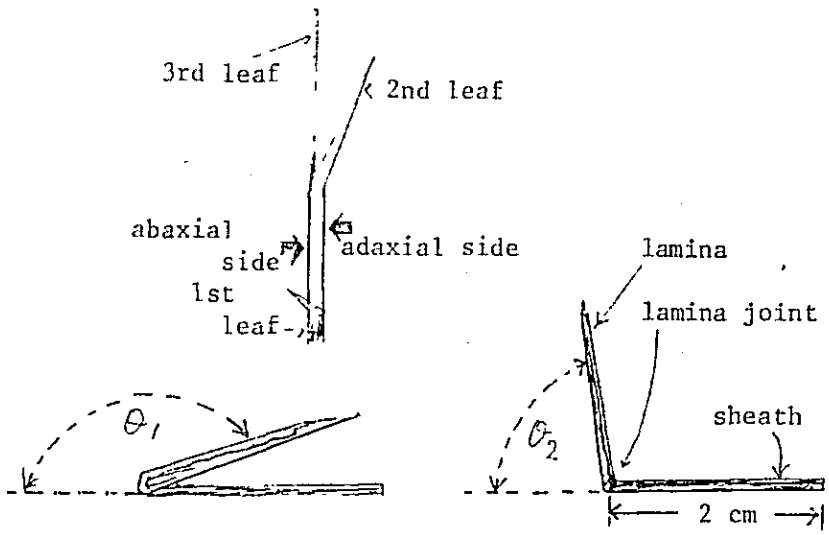


Fig. 9 Measurement of lamina inclination induced by IAA and its promotive and inhibitive effects by herbicide

Auxin-induced lamina inclination(θ_1) and its inhibitive angles by herbicide (θ_2) by semicirculer protractor.

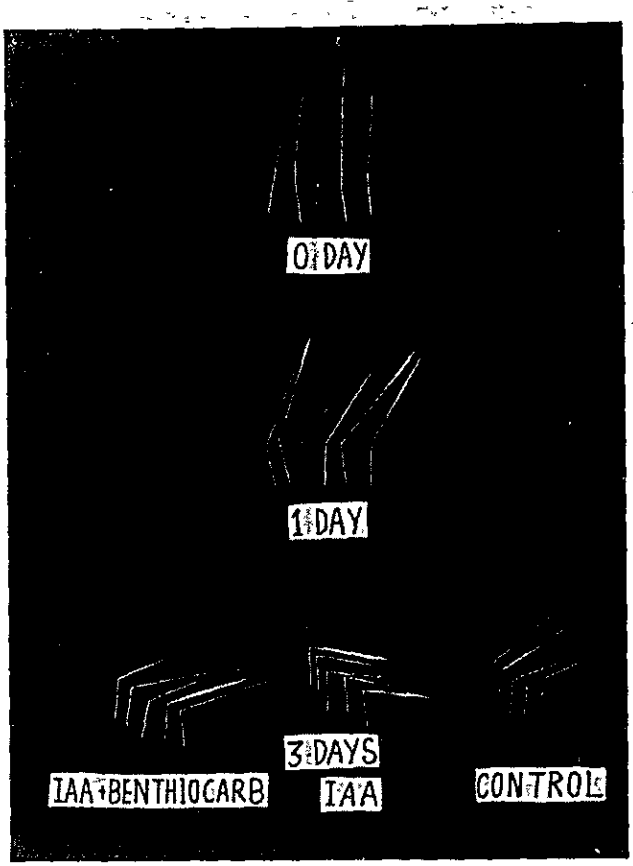


Fig. 10. Bioassays of bioregulator activities by using lamina joint sections in rice plant seedlings.

The 2nd leaf sheaths of 7-day old seedling (about 2.8th leaf stage) were cut down to float on the buffer solution (0 day in picture). One day after ageing in the buffer, leaf sections with small angle (I day in picture) were transferred to new buffer solution with IAA (IAA in picture), with IAA pluss herbicides (IAA + Bentiocarb in picture) and without IAA (CONTROL in picture) for 2 days (3 day in picture). Angles were measured on " I day " and " 3 day " and lamina inclinations were caluclated as differences between each day-angles measurements.

The manual of the cultivation method of rice seedling were shown in Appendix III (iv, at page). Rice seedling were cultured on the agar plate in the darkness in place of under light conditions like the seedling with green color in picture of Appendix III.

Seven day-old ethiolated seedling were used for assay. These procedures were illustrated in Fig. 8. Lamina inclination were measured by semicircular protractor illustrated in Fig. 9 after incubation of lamina joint sections in buffer solution with herbicide.

As case studies, amiben (23.6 %), benthiocarb (50 %) glyphosate (41 %) and oxadiazone (12 %), and thier mixtures were assayed by auxin-mediated lamina inclination system.

Most herbicides including ones mentioned above have no effects to lamina inclination without auxin.

Fifty mM K-phosphate buffer (in Appendix I, i at page) with IAA (2×10^{-5}M), with IAA plus herbicide and without IAA (control) were used for assay.

Results and Discussion

Fig. 10 showed the pictured demonstration of herbicide assay processes and its calculation method. One day after ageing in the 50 mM K-phosphate buffer (pH 5.5) solution under the dark condition with 30°C, We should select the sections with 30-45° lamina inclination to get good results (1 day in Fig 10).

As the acidity affects cell elongation, pH dependency on the IAA-mediated lamina inclination in Indica and Japonica rice were investigated (Fig. 11).

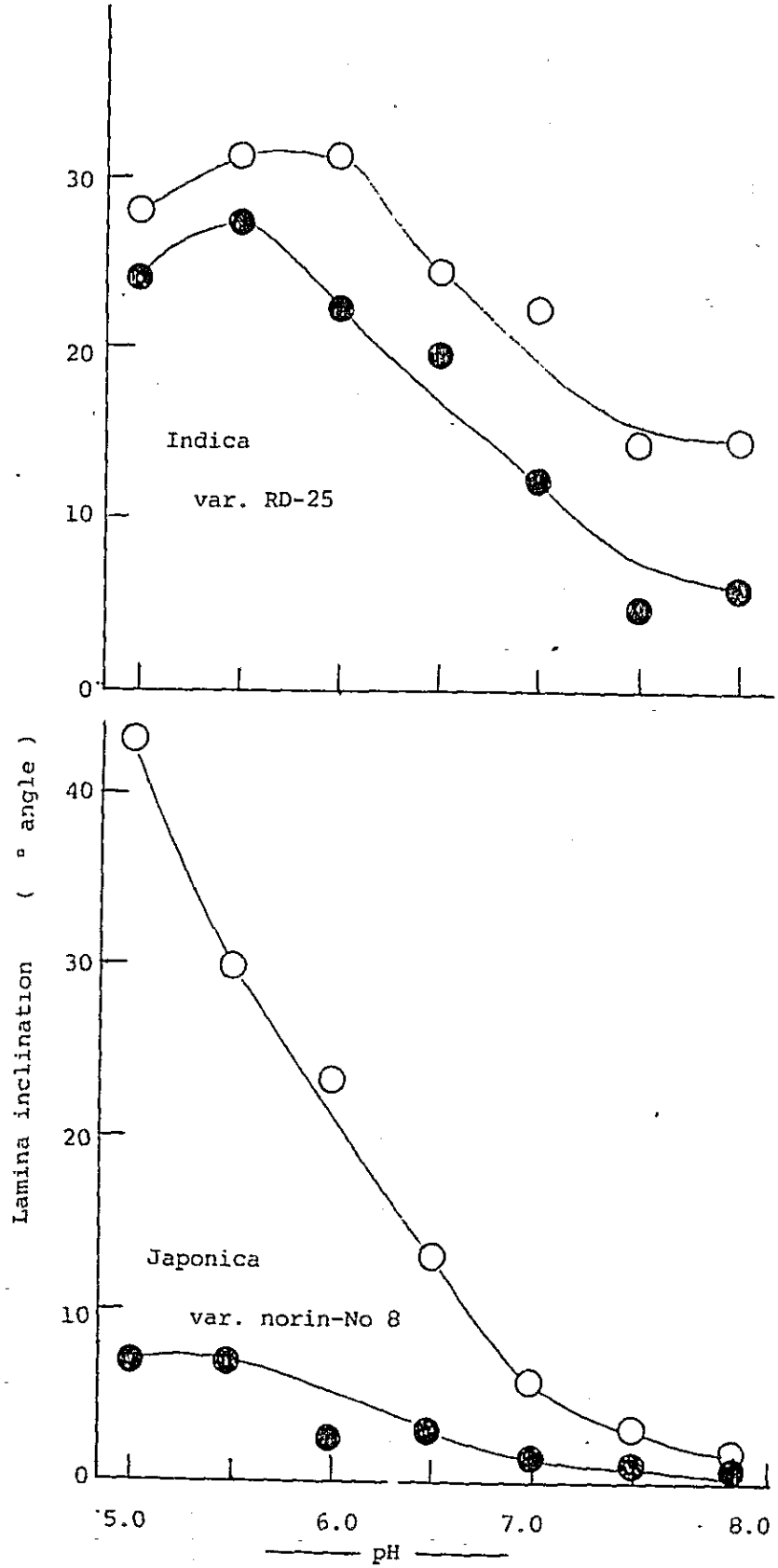


Fig.11 Effect of pH on the auxin-mediated lamina inclination in Indica and Japonica rice

One day after aging in a each buffer, the section was incubated in the same buffer with(○) and without(●) IAA for 2 days

Maximal angles in both of endogenous IAA (without IAA in Fig. 11)- and exogenous IAA (with IAA in Fig. 11)-induced lamina inclination were at pH 5.0 - 6.0. Then, buffer solution of following experiments were adjusted to pH 5.5.

Table 2 showed the varietal differences of lamina inclination in local Indica rice varieties. In this experiment, it may come into some questions that exogeneous IAA (with IAA) induced lamina inclination is not always bigger than endogeous auxin (Control)-induced ones.

So far, there were big varietal differencese in endogeous auxin-induced lamina inclinations. These differences on 2nd -leaf lamina inclinations, in vitro, may reflect the some metabolic characteristics of their growing proceses in intact plant.

Fig. 12 shows the effects of some herbicides on the IAA-induced lamina inclination. Amiben (cell elongation action like auxin) promoted IAA-induced lamina inclination until about 10 ppm. Glyphosate (amino acid metabolism inhibition) has no effect on lamina inclination. Oxadiazone (light-activated action inside plant) inhibited it at high concentration only. Benthiocarb (nucleic acid and protein synthesis inhibition) inhibited IAA-induced lamina inclination, and its I_{50} was 10 - 15 ppm. We should replace herbicide concentration from " ppm " to " Mol " , and may result real action pattern on each herbicide.in this table .

Anyway, it is very intersting in comparison between lamina inclination inhibitive pattern and the known mode of action of their herbicides.

We can also detect the additive, synegistic and antagonistic action between herbicides by using this lamina inclination test.

Table 2 Varietal differences of lamina inclinations in local Indica rice varietietis

Variety	CONTROL	with IAA
1. Ta Paw Rays	29.7	27.0
2. Khoa dok mali	20.4	33.6
3. Lung Pro Tea	16.8	12.5
4. Nahng mon S-4	16.4	16.5
5. Lab Mae Nahng	8.0	6.45
6. Nahng Nyang(4)	9.8	9.0
7. Nahng Pra-ya(3)	7.0	7.5

Experiments were performed in the same way as in Fig 8 and Fig 9 .

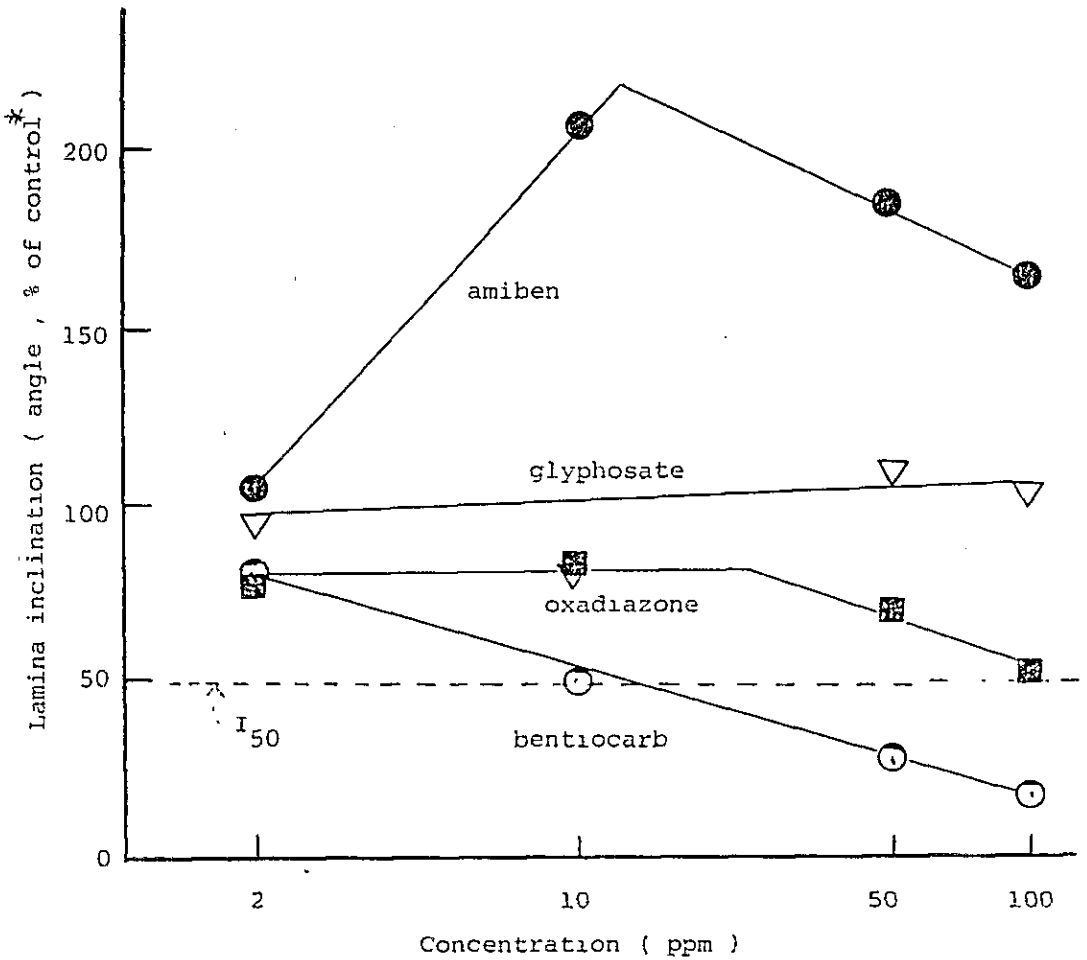


Fig. 12 Effect of herbicides on the auxin-mediated lamina inclination in Indica (RD-25) rice seedling

* " control " means the value in IAA-containing buffer solution.

Proposal

NWSRI should have fundermental research works as a central institute in the weed science field of Thailand and Southeast Asia.

In the physiological and biochemical approach of weed sciences, following equipments are essential for NWSRI.

1. Low-temperature (0 - 5 ' C) laboratory. 2.4ตร

   Pure habu box-type $2.5^{m} \times 1.7^{m} \times 2.0(H)^{m}$

   By Hirasawa Co L.T.D. (Japan)

2. Electrophoresis apparatus, 2 sets

   Power supply (ISCO , USA)

   Disc electrophoresis SJ-1060D

   " SJ-1060DC11

   Slab electrophoresis SJ-1060SDH

   low -temperature circulator CCM-4

   By Ato Co L.T.D. and Ikeda Sci. Co.L.T.D. (Japan).

3. Specrophotometer with 4 quarz cells

   Hitachi, model 200-20

   By Hitachi Co L.T.D. (Japan)

4. Angle rotor with test tubes

   Hitachi RPR 18-3 By Hitachi CO.L.T.D. (Japan)

5. Slide projector as light sources of oxygen electrode

   High lux H type 2 sets

   By Master Co. L.T.D. (Japan)

Main Schedules during Stay in Thailand

June 28	Arrival to Bangkok
29	Greeting to JICA office, Thailand
30	Research discussion with counterparts
July 12	Tour to Singha Buri
28	NWSRI seminar I
August 2-3	Tour to Kanchanaburi and Suphanburi provinces
4	Visiting to Chulalongkorn University
9-12	Tour to Northeast area
15	NWSRI seminar II
16-20	Tour to North area
29	NWSRI seminar III
30	Report to DOA and JICA office
31	Leave Bangkok

Visit to Institutions

Pimai Rice Experiment Station, Pimai, Nakornrachasema Province

Chief : Mr. U-thai Wongvises

Ubolrachathani Rice Experiment Station, Ubolrachathani Province

Chief : Mr. Chamraas Prongsiriwattana

Mahasarakarm Field Crop Experiment Station, Mahasarakarm Province

Cheif : Mr. Panas Songserm

Sanpatong Rice Experiment Station, Sanpatong, Chiengmai Province

Chief : U-thai Tanapanyo

Phan Rice Experiment Station, Phan, Chiengrai Province

Chief : Mr. Chamnong Pulsawat

Suphanburi Rice Experiment Station, Suphanburi Province

Chief : Mr. Thanad Sukpragarn

Mae Klong Irrigation Project, Kanchanaburi Province

Chief in JICA : Dr. T. Misawa

Plant Physiology Section, Botany and Weed Science Division, DOA, Bangkhen, Bangkok

Mrs. Yao-wanut Hongsuranond

Bacteriology Section, Plant Pathology and Microbiology, DOA, Bangkhen, Bangkok

Mrs. Sunetra Bhavichitra

Kasetsart University, Bangkhen, Bangkok

Kasetsart University, Kamphaengsaen Campus, Kamphaengsaen
Dr. K. Imaizumi , Dr. H. Tanaka
Chulalongkorn University, Department of Science and the Scientific and
Assist. Prof. Rachina
Technological Research Equipment Center, Bangkok

Veterinary Bioloics Center M , Pak Chong, Nakorn . Rajsima Province

Mr. Chai Jomkoa

Acknowledgements

The short stay (about 9 weeks) in Thailand gave me one of the most pleasant & fruitful experiences in my life. I am very pleased to have had the communications and discussions with all NWSRI staffs through out experiments, 3-times seminars, 3-times study tours, and so on.

I should express my gratitudes to whom it might concern for kind offering me on opportunity to come over and research work here, first.

I'd like to thank cordinally to Mr. Visut Chandrangsu, the Director of Botany and Weed Science Division and Dr. Paitoon Kittipong, Chief of Weed Science Research Institute for enough arrangements to do our research works.

I would also acknowledge to all research staffs and secretariates in NWSRI for their heartful kindness and volitional introduction of agricultural and experimental information in Thailand to me.

Further, I have to express my appreciation to Dr. Kenji Noda, the leader of NWSRI Project, Mr. H. Hyakutake and Mr. K. Kojima, the project experts for their heartful supports and cooperation to me.

Appendix I. Buffer solution

The preparation of buffer solution is very important for the physiological and biochemical research works. Buffer which is prepared by two or more chemical compounds should be used at the pH with strong buffer action. Examples are as follow :

1. Potassium - phosphate buffer (0.05 M K-phosphate, pH 6.5).

Use the potassium phosphate, monobasic (KH_2PO_4, Mwt = 136.09) and potassium phosphate, dibasic (K_2HPO_4, Mwt = 174.18). The application of sodium (Na) types instead of potassium phosphates have no problem. Disolve 6.8045 g (136.09 x 0.05) KH_2PO_4 in about 800 ml D.W. and fill up to 1 ℓ by D.W.---- ①. Disolve 8.709 g (174.18 x 0.05) K_2HPO_4 in about 800 ml D.W. and fill up to 1ℓ by D.W. ---- ②.

After adjustment of pH meter by standard solution (pH 6.86 and pH 4.01 at 25°C), electrode should be dipped in 200 ml (or more if necessarily) KH_2PO_4 solution ①; and needle of pH meter will indicate about 4.5 (acidic). Adjust this needle to at pH 6.5 by pouring K_2HPO_4 solution ② (alkaline) with pipette. That is all. After these operation, wash the electrode head by D.W. and stand it in D.W. By these operation procedures, you can make discretional pH buffer solution with different concentrations from 5.5 - 7.5 (pH solution with under 5.5 & over 7.5 have weak buffer action).

2. Tris-Hcl buffer (0.1 M Tris, pH 7.5)

Use tris {tris (hydroxy methyl) aminoethane. $(HOCH_2)_3\ CNH_2$, Mwt = 121.14} as a compound. Disolve 12.114 g tris in about 800 ml D.W. In addition, make 1 N, 0.5 N and 0.1 N HCL by its dilution (usually concentrated HCL reagent is almost 12 N).

After adjustment of pH meter mentioned above (in this case, pH 6.86 and pH 9.05 solution at 25°C), electrode should be dipped in this tris solution (about 800 ml), and needle of pH meter will indicate about 9.0 (alkaline).

Adjust this needle to at pH 7.5 by pouring diluled Hcl solution (in this case, 0.5 N Hcl solution's better)with pipette. After these operation, tris solution should be filled up to 1ℓ by D.W. Wash the electrode head by D.W. and stand it in D.W.

Appendix II. Nutrients components for water culture in rice plants

(Kimura's B soulution)

Stock No.	Nutrient	Final Conc.	fold	Stock Sol.	ml of Stock Sol./l
		mg/l		g/l	ml/l
(A)	$(NH_4)_2SO_4$	48.2	x50	2.41	20
	K_2SO_4	15.9	x50	0.795	20
	$MgSO_4$	65.9	x50	3.295	20
	KNO_3	18.5	x50	0.925	20
	KH_2PO_4	24.8	x50	1.24	20
(B)	$Ca(NO_3)_2$	59.9 mg/l	x50	2.995 g/l	20 ml/l
(C)	$FeCl_3$	5.0 mg/l	x50	0.25 g/l	20 ml/l

Make stock solution (A), (B) and (C), respectively.

In (A), about 900 ml D.W. are stirred by magnetic stirrer and add 2.41 g, $(NH_4)_2SO_4$ in the D.W., first. After complete disolution of $(NH_4)_2SO_4$, add next nutrient in the same solution. Repeat this to KH_2PO_4, and then, fill the nutrient solution to 1ℓ by D.W. Store the stock solution (A), (B) and (C) in the refrigerator until use. Be caution (A)'s contamination in a month, specially, and renew it by the method mentioned above.

Appendix III. Water culture of rice plant.

1. Germination of rice seeds.

Rinse the rice seeds by tap water 2 times. If you have the seeds floating on the water, throw out them with water. Put the seeds with enough water (D.W.) in the thermo-controlled container (30^{C}C) with or without light for 2 days. One day after soaking, rince the seeds by D.W. 2 times and pour small amount of D.W. Then, put them in the same container again for one day more.

2. Culture of germinated seeds in nutrients - medium.

(1). Put the 2-layer guasze bandage in the petridishes. Pour the nutrients (Table in appendix II) in the petridishes and put the germinated seeds on the guaze bandage, and culture in the same container as mentioned above. Change the nutrients every 3 days (Figure).

(2). Make the 0.8 % agar nutrient solution(Table in appendix II) with boiling(use the 2l-flask to make 1l solution because the protection from overflow of solution by boiling. Take care.) After the agar solution become hard, dip the seeds in the agar plate. Keep the seed-embryo up (Figure). In the room experiment, we usually use (1).

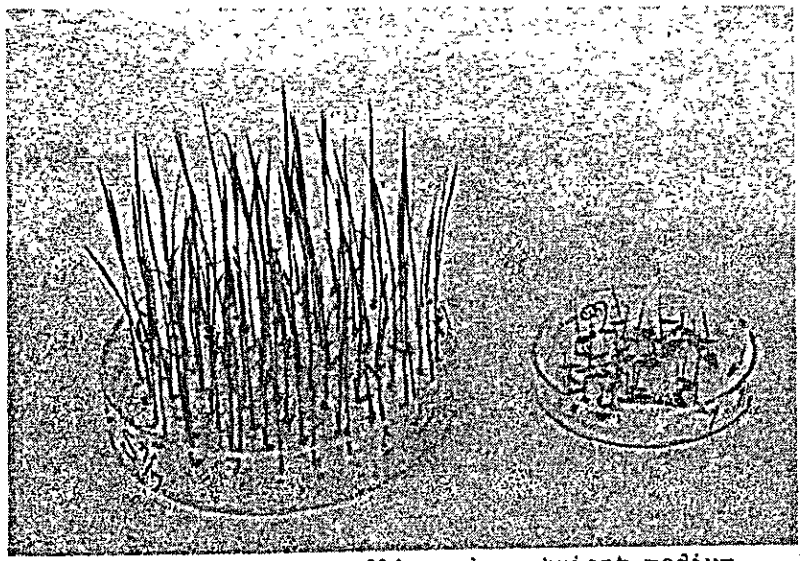
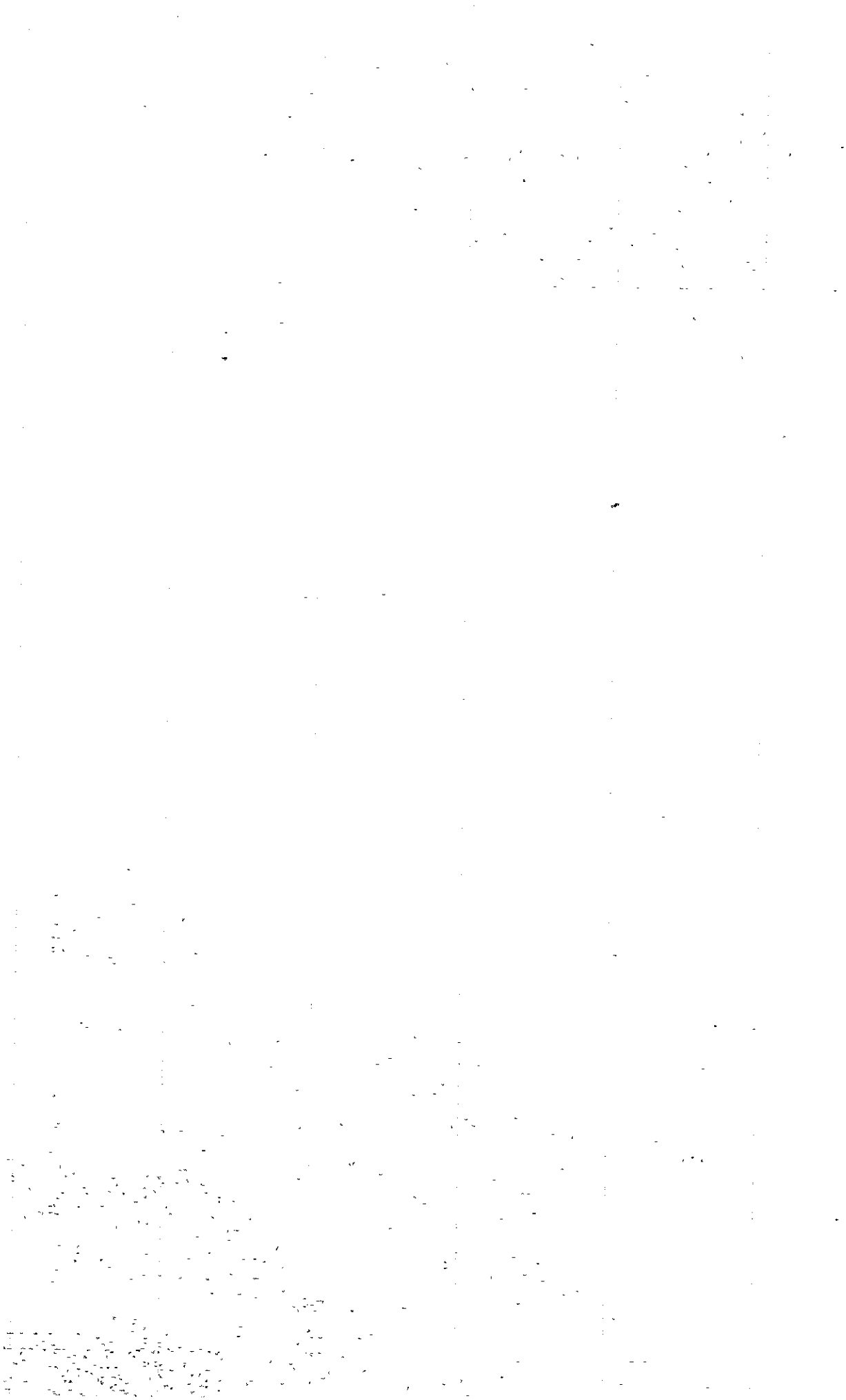


Figure. Culture of rice seedlings in nutrient medium

Agar-plate with nutrients (left) and gauze-bandage with nutrients (right). Tight support of seedlings by agar or guarze can help the upright growth of seedlings.

芝山秀次郎専門家帰国報告書



帰国報告書

タイ雑草研プロジェクト

派遣専門家　芝山秀次郎

任期　1981 2 6 ～ 1983. 3 30

ＪＩＣＡの研究協力、技術協力プロジェクトの影響力は極めて大きいと感じたが、金額が大きなわりにそれを十分に生かしていない面がある。その問題点を私が感じた範囲であげてみた。

一口で言えば、現在の協力体制は機材（物）の供与が中心であると思うが、これを人材の育成面へと重点を移す必要があると考えた。

機材については、いくら物を供与しても動かないものでは意味がないし、また、たとえ動いても、物の場合５年もしたら古くなり使用不能となってしまう。しかし、人の友好関係はずっと続くものである。

1　機材供与システムの不備が専門家の活動の足かせとなっている。（別紙参照）

2. 研修について

研究協力、技術協力の場合、３～６ヶ月という期間は研修として余りにも短かすぎる。

また、現地側スタッフには大学院で勉強して修士号、博士号を取得したいという希望が極めて強いが、優秀なスタッフにその機会を与えたい。

ＪＩＣＡ研修生を私費留学なみの扱いで日本の大学に受け入れることはできないか。

3. 協力研究と学位、国際学会への派遣

協力研究の成果のシンボルとして、現地の優秀なスタッフの博士号（学位）取得、国際学会会議での成果の発表が考えられる。

学位については、ＪＩＣＡ本部としても、研究協力プロジェクトの中心課題として重点をおく必要があると感じた。大変なことではあるが、現地側へのインパクトは極めて大きく、研究協力である以上、最重点としてもよいのではなかろうか。

専門家あるいは現地側スタッフの国際学会、会議への出席、発表も国際的反響が大きく、必要不可欠である。日本側供与ワクの内で旅費がとれなければ、現地業務費、研究費の弾力的使用等ができないだろうか。

とくに雑草研プロジェクトの場合、２年後（１９８５年）にアジア太平洋雑草学会（ＡＰＷＳＳ）の開催という願ってもない国際的活動、国内外への成果の公表の場となることが確定しており、その前準備として任国外出張等の必要性が生じている。

4. ＪＩＣＡ本部側の体制

現在の体制は、担当者の方の個人的努力で現地専門家の要望に対応しているように見うけられる。しかし、それには限界があり、機材問題等を考えると１プロジェクトに１人の担当者が

必要と思う。

例えば、現在の業務調整員の制度を改めて、仕事は大変になるが、プロジェクト担当と調整員を兼務し、その人には現地と東京を常に往復して両方の調整にあたってもらうということはできないだろうか。

個々の専門家あるいはリーダーの方にとっては、事務処理等負担が増える面も大きいとは思うが、プロジェクトの進展上はるかに大きなメリットがあるように思われる。

以　上

（１９８３年２月２４日）

○ 機材供与の現状を問題とする理由

1. 専門家の任務は機材の整備ではない！

専門家の本来の任務は、機材の使い方を現地スタッフに訓練し、それによって研究成果、技術の向上をはかることである筈。

ところが現状は、主要機材の多くに不備があり、時期遅く届き、やっと整備する頃は任期終了となってしまう。技術移転の期間がとれない。

2. ハードウエア（機材）の供与から、ソフトウエアを含めたシステムとしての供与へ！

現地ですぐに機材を使用しうるという観点から、必ず、周辺機器、消耗品等を含めたシステムとして供与する。

ランニングコストは現地側が負担すべきといった建前の議論は百年河清を待つごとしで、まず、成果を出してみせなければ認識は深まらない。

現地側の現場の生の声は〝museum〟、〝使えもしない機材がほこりをかぶって陳列されている〟、といったことが多い（当プロジェクトのことではなく一般論として）。

○ 対　　策

1　当面の問題と対策：次　　頁

2　専門家の活動を助けるため、機材の 1/4 位は年度なかばまでに購送する。

3　機材の発注を５００～1,000万円単位でまとめ、各社に、現地すえ付け、整備まで責任を持たせた価格で見積らせる。

4. 機材の選定課程では、１度、専門家あるいは業務調整員を東京に呼び、機種、周辺機器、消耗品等を確認させる制度をつくる。

1. 関連する必要機材、付属品、説明書の欠除、不備

　企業の営業担当者が対応するので必要品が分らない
　見積価格を低くするため、本体価格のみあげている

2. 消耗品〔機器を使用するための試薬、ガラス器具、チューブ、記録用紙等〕、修理用部品の不足

　プリンターが来て用紙がない等のことが多い
　現地で入手困難なものが多い

3. 余りに最新型のものが来る

　コンピューター組込み機器等最新型ほど現地修理が不可能、取扱いが難しい

○当面の対策

1. 企業の営業担当者でなく、技術者に関連機材、消耗品をリストアップさせる。
2. 関連機材、付属品はできるだけ数多くつけさせる。（不足は致命的だが多い分は困らない）
3. 消耗品は、通常使用で２～３年分つけさせる。（有効期限に注意）
4. 現地代理店がしっかりして修理可能の機種を優先する。（最新型はさける）
5. 自動車等、標準装備プラス熱帯向け仕様を義務づける。（強力なエアコン）
6. あい見積では、低価格ではなく内容の良悪で決める。（現地で使用できる機材を送るため是非必要）

以　上

2. 昭和５８年　日本雑草学会講演要旨より

Differential Responses of Rice Varieties and Some Graminoous Weeds to Herbicides

Patcharin Wanichanantakul, Hiroshi Hyakutake and Orasa Wongkasem (Botany and Weed Science Division, Department of Agriculture, Thailand)

In Thailand, with labor costs increasing by 3-4 times, chemical weed control has been increasing in dy fields. However, the phytotoxicity of herbicides occurs frequently with different patterns in diffe .t regions, where approximately forty recommended rice varieties plus several local rice varieties are re cultivated. Therefore, it is necessary to investigate the differential phytotoxicities of herbicides, several representative rice varieties from the point of effective utilization of chemicals in farmers' ·ld. The present studies were conducted to obtain basic data in this point together with the control o ·aminoous weeds in paddy fields.

Ten recommended rice varieties in Thailand, (indica type) : RD-7, RD-9, RD-21, RD-23, RD-25 (hybrid iety), Khao Ta Hang 17, Nahng Mon S-4, Khao Dawk Mali 105, Nahng prayah 132, and Leuang Pra-tew 1 al variety), a Japanese rice variety : Nihonbare, and three graminoous weeds in paddy field, Cr.. .ufipogon, Ischaemum rugosum Salisb, and Echinochloa crus-galli (L.) Beauv. were selected and fifteen weed seeds were planted at the depth of 0.5-1 cm in plastic pots containing Rangkhea clay soil. ·Oxazon, CNP, benthiocarb, molinate and butachlor were applied as pre-emergence herbicides, while and 2,4-D were applied as post-emergence herbicides at 2.5-3.5 leaf stage of rices and weeds. The lants were harvested 14 days after treatment. The daily temperature and relative humidity of green ·se 20-27°C and 42-105% respectively.

Each rice variety showed somewhat different response to different herbicides. Among the rice varieties onbare was most tolerant to all the herbicides tested. Among indica type, the difference in herbicide ·ponse between hybrid variety and local variety was slight. Rice varieties responded extremely differ ·ree, ranging from susceptible to tolerant, to benthiocarb. Further investigations on these differen ·ponses of rice to herbicides will be continued from physiological and biochemical aspects.

Table 1. Differential Responses of Rice Varieties and Graminoous Weeds to Herbicides.

Varieties / Herbicides	RD7	RD9	RD21	RD23	PD25	Khao Ta Hang17	Nahng mon S-4	Khao dawk mali 105	Nahng pra yah 132	Leung pra tew 123	Nihon bare	O. rufipogon	I. rugosum	E. crus-galli
Oxadiazon	MS	MT	MT	M	M	M	M	MT	M	M	MT	-	S	-
CNP	M	M	MT	M	M	M	M	MS	M	M	MT	M	S	S
Benthiocarb	MT	MS	T	S	MT	MT	T	S	M	MT	T	MS	S	S
Molinate	M	M	M	MS	M	M	M	MS	M	MT	T	MS	M	MS
Butachlor	MS	M	M	M	M	MT	T	MT	M	MT	T	MT	S	S
Propanil	M	M	MT	M	M	MT	MT	M	M	MT	T	MT	S	S
2,4-D	MS	MT	MT	MT	MT	M	MT	MS	M	M	M	MT	MT	MT

S = Susceptible, MS = Moderately susceptible, M = Moderate, MT = Moderately tolerant, T = Tolerant

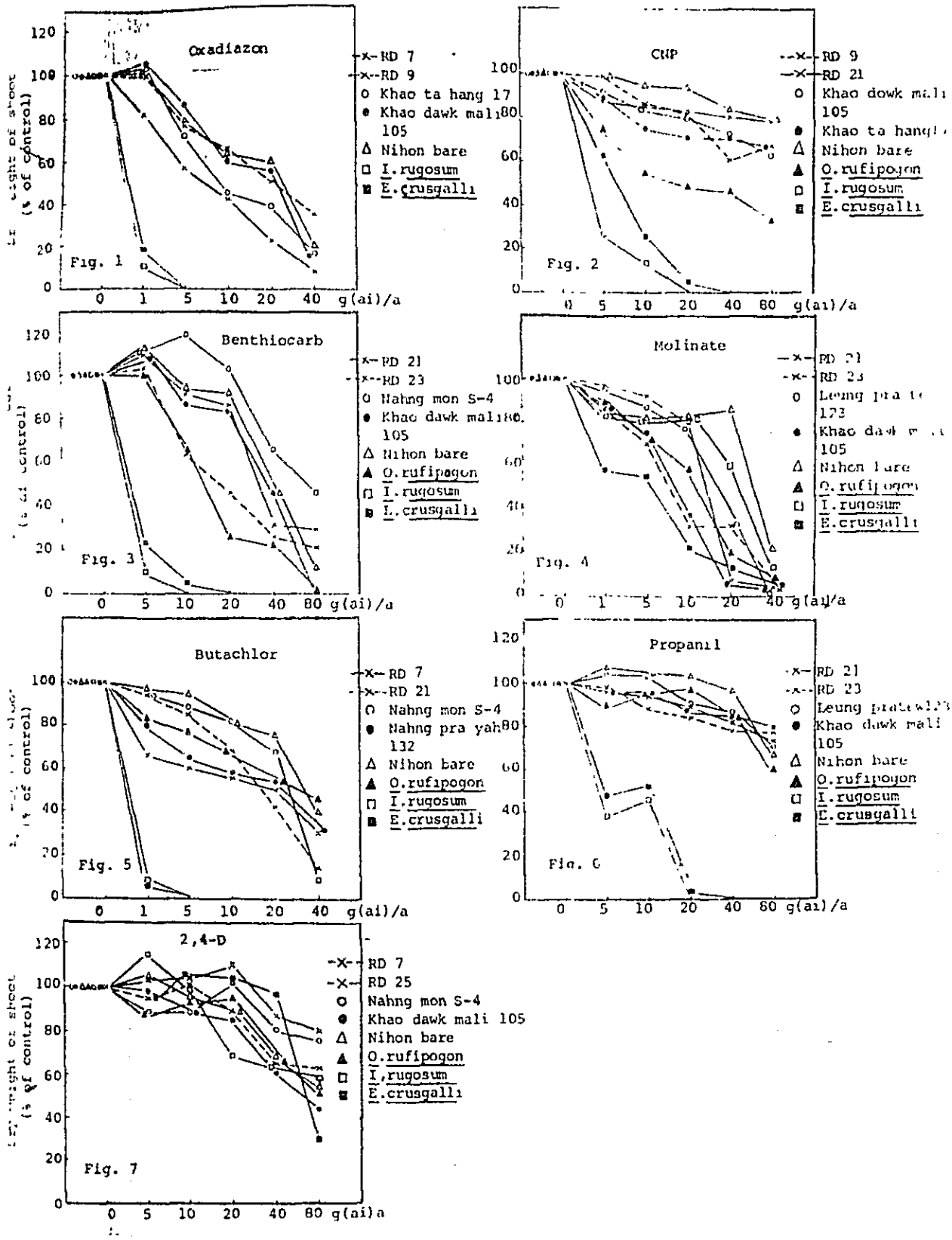


Fig1:7The Effects of Herbicides on Initial Growth of Rice Varieties and Gramineous Weeds

Some Ecological Characters of Wild Rice (Oryza rufipogon) in Deep-Water Rice Areas in Thailand.

Hiroshi Hyakutake, Siriporn Zungsontiporn and Chaiyot Supatanakul (Botany and Weed Science Division, Department of Agriculture, Thailand)

Wild rices as weed are a serious threat to direct sowing rice areas in Thailand. Therefore, fundamental ures of wild rices such as seed dormancy, emergence, growing behavior and effects on the yield of cul ated rice should be clarified for taking counter measures on the control.

Lep Mue Nahng 111 (floating rice) and Oryza rufipogon, densely distributed, were used as cultivate ild rices respectively, and they were grown in concrete pot 0.5 m^2 containing Bangkhen clay soil. O. rufipogon shattered easily before full ripening and they stayed in dormancy. The emergence rate the wild rice from deeper soil was comparatively lower. When seeds of O. rufipogon which had failed to ge were transferred to aerobic condition, they started to germinate proving a high requirement of xygen than Lep Mue Nahng (Table 1 & 2). O. rufipogon, prostrate type, gained innumerable number of till to plant height higher than those of Lep Mue Nahng in cultivated rice, but heading time was pro- ded to that of the cultivated rice, giving the sibilities of cross polination. For the number of icles/m^2, weight of unhulled rice in O.rufipogon much lower mainly due to fewer spikelets per pa- (Table 3). The conditions of the competition were not appropriate since the two species propagated to innumerable density. Under the seeding density, the yield of Lep Mue Nahng was mely lowered (Table 4).

Table 2. Germination of digged-out seeds

Water regime	Seeding depth (cm)	Lep Mue Nahng 111	Oryza rufipogon	Nihonbare
Submerged	1	6 %	18 %	%
	3	5	66	
	5	4	57	13
	7	0	46	15

* Unemerged rice seeds were recovered from soil and were put in Petri dish under the temperature of 30°C.

Table 1. Effects of seeding depths under different water regimes on emergence of rice seedlings.

Water regimes	Days after seeding / Seeding depth (cm)	Lep Mue Nahng 111 (Indica type)			Oryza rufipogon wild rice			Nihonbare (Japanica type)		
		5	10	20	5	10	20	5	10	20
Moist*	1	49	65	89	45	66	90	82	92	99
	3	47	81	100	16	68	86	25	80	94
	5	23	86	100	0	65	90	0	64	99
	7	0	46	77	0	4	47	0	0	60
Saturated**	1	37	49	72	25	70	81	69	89	90
	3	37	44	77	5	47	74	14	55	69
	5	5	68	88	2	31	72	0	15	87
	7	0	11	58	0	0	63	0	0	47
Unemerged***	1	0	4	4	0	0	0	0	7	25
	3	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0

Figures indicate percent of emergence. Soil moisture content. Average soil temperature.

* 38.8% 24.2 C (10.00 A.M.)-28.5 (15.00P.M.)

** 40.5% 23.8 27.9

*** 47.8% 21.8 26.7

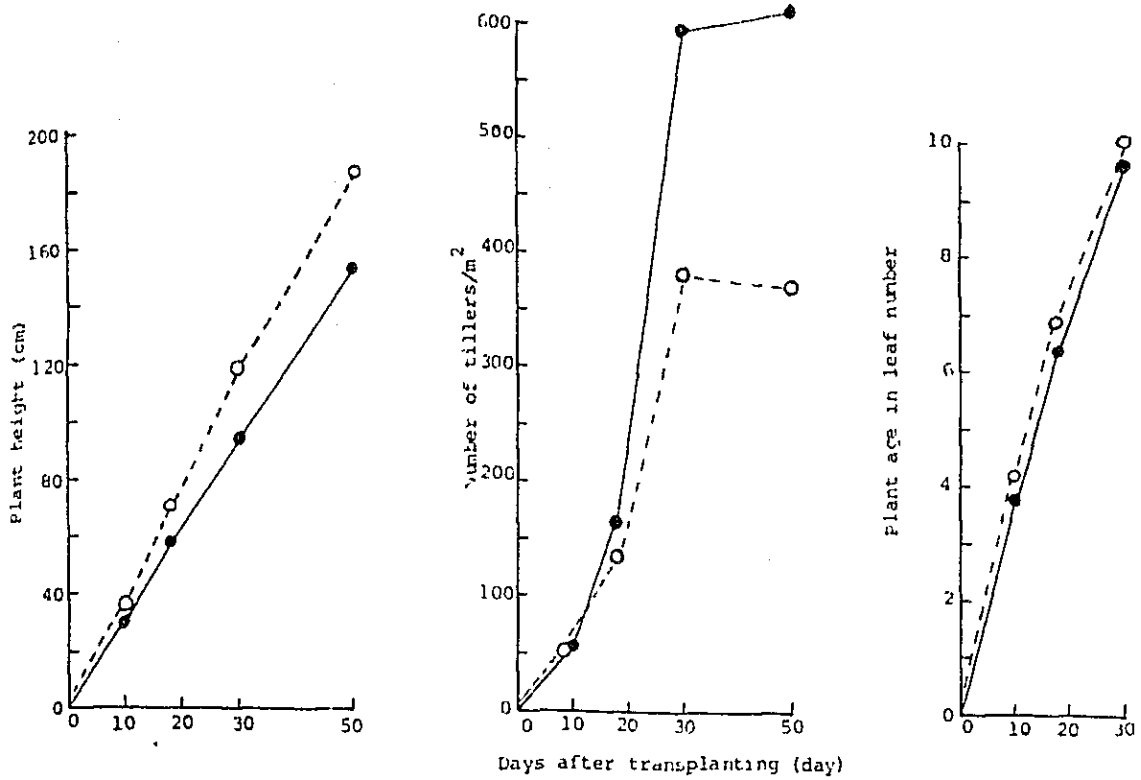


Fig. 1. Growing processes of cultivated rice (Lep Mue Nahng 111) and wild rice (Oryza rufipogon).

o- - - o Lep Mue Nahng 111 •——• Oryza rufipogon

Table 3. Comparison of several characters between cultivated and wild rices at the harvesting time.

Characters / Rice spp.	Heading date	Date of maturity	Culm length (cm)	Panicle length (cm)	Number of panicles/m^2	Weight of unhulled rice (g/m^2)	Weight of straw (g/m^2)
Lep Mue Nahng 111 (floating rice) cultivated rice	Nov.9, 1982	Dec. 5, 1982	254	29.8	12[illegible]	460	3,548
Oryza rufipogon wild rice	Oct. 28, 1982	Nov.12-27, 1982	256	25.2	306	246	3,742

Transplanting date : June 14,1982, rice seedlings of 1.0 leaf-stage.

Table 4. Competition between cultivated rice (Lep Mue Nahng 111) and wild rice (Oryza rufipogon).

Basis of competition, Number of seeds/m^2 / Characters		Culm length (cm)	Panicle length (cm)	Number of panicles/m^2	Weight of unhulled rice (g/m^2)	Weight of straw (g/m^2)
Lep Mue Nahng 111	200	271	26.3	64	214	2376
Oryza rufipogon	0	-	-	-	-	-
L.	200	277	26.6	78	260	2614
O.	25	258	26.8	25	37	252
L.	200	258	26.2	75	244	2480
O.	50	223	28.5	73	36	418
L.	200	247	23.8	95	322	2260
O.	100	237	30.0	85	29	750
L.	200	273	24.3	39	130	1176
O.	200	270	29.0	135	26	982

Seeds of cultivated and wild rices were mix-broadcasted at the same time in a square concrete pot of 0.5 m^2 in size.

Distribution and Habitats of Wild Rice in Deep-Water Rice and Other Areas in Thailand

°Hiroshi Hyakutake, Prasarn Vongsaroj, Chaiyot Supatanakul and Siriporn Zungsontiporn (Botany and Weed Science Division, Department of Agriculture, Thailand)

Wild rice species as weeds are causing great concerns in direct seeding rice areas, especially in deep water-rice areas of Thailand. The areas are Central, Northern and some parts of Southern Regions. In these areas, rice culture is being practised by direct broadcoasting on dry soils after the first ploughing in March to April. With coming of rain, wild rices germinate at the same time with cultivated rice, therefore offer serious competition from the beginning of their initial growth. Thus, the infestations of wild rices reduce yield of cultivated rices, lower the grade of rice due to the presence of wild rice and cause cross pollination with cultivated species of rice. The present investigation was made from March 1981 to March 1983 to find geographical distribution of wild rices in Thailand and also to find some relationship between rice cultivation method and infestation of wild rices in conjuction with habitats.

The provinces of heavy infestations with wild rices are Pisanuloke, Sing Buri, Nakhon Nayok, Prachinburi, Nakornsrithammaraj and Songkla, where rice cultivation are mainly practiced by direct seeding method. The wild rice species observed in Sing Buri, some part of Nakhon Nayok and Prachinburi was identified as Oryza rufipogon. The other wild rices are under investigation on their species identification.

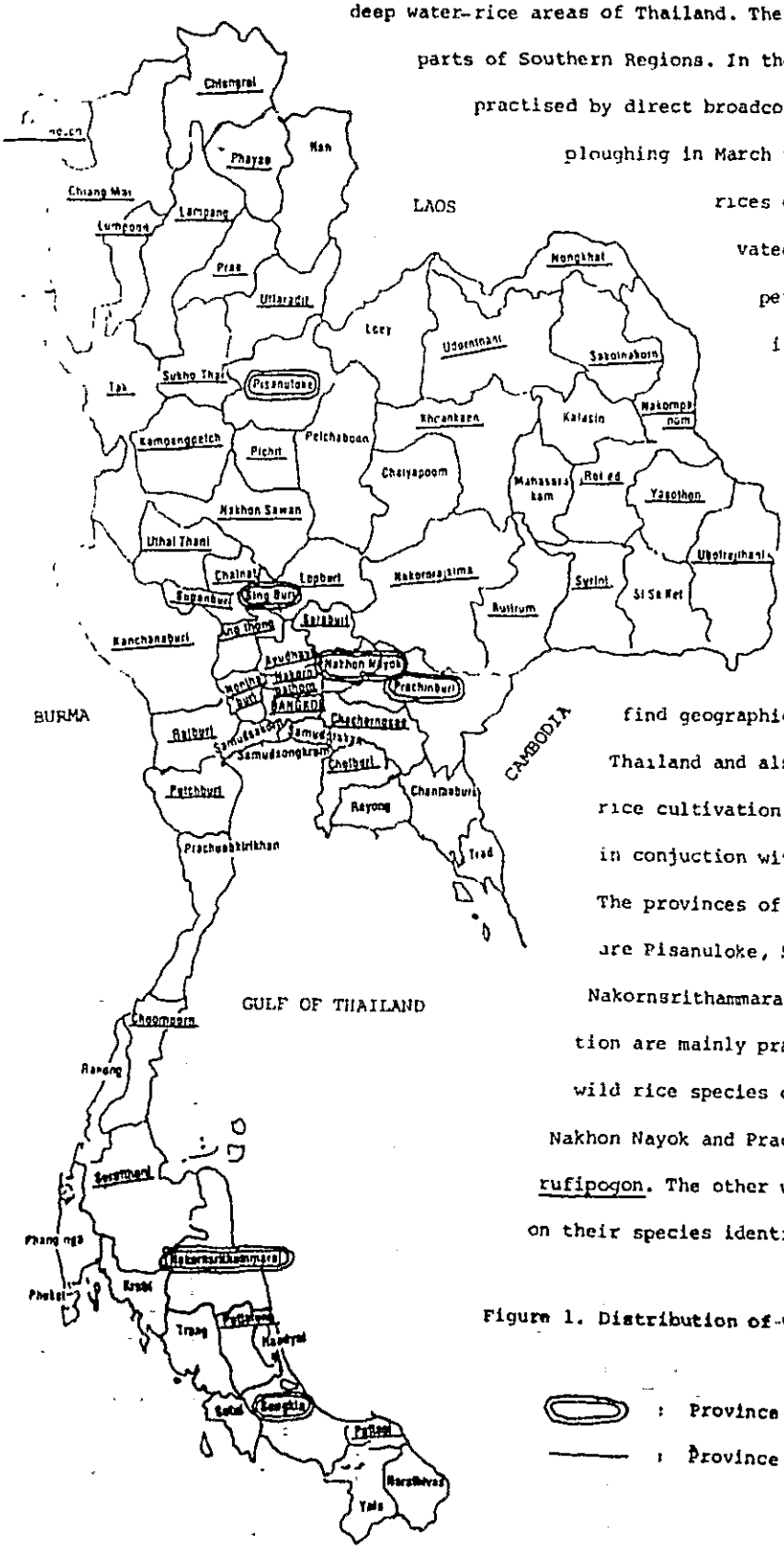


Figure 1. Distribution of Wild Rice in Thailand.

: Province of heavy distribution

: Province of moderate distribution

Region	Province	*Rice cultivation method	**Habitat
Northern	Kampangpetch	1,2B	2,5,7,8
	Chiangmai	1,2C	5
	Chiangrai	1	5
	Phayao	1	9
	Tak	1,2C	5
	Nakhon Sawan	1,2B	2,5,7,8,9
	Prae	1,2C	5
	Pichit	2B,2A	1,5
	Pitsanuloke	1,2A,2B,2D,2C	2,5,7,8
	Lampang	1,2C	5
	Lumpoon	1	5
	Sukho-Thai	1,2B	2,5,7,8
	Uthai Thani	1,2B	2,5,7,8
	Uttaradit	1,2C	5
Northeastern	Khoan kaen	1,2B	5
	Nakornpanom	1,2B	7,8
	Mookdaharn	1,2B	5,7,8
	Burirum	1,2B	5,8,9
	Yasothon	1,2B	5
	Roi-ed	1,2B	5
	Sakolnakorn	1	7,8,5,9
	Surin	1,2B	5
	Nongkhai	1,2B	5
	Udornthani	1,2B	5
	Ubolrajthani	1,2B	5
	Nakornrajsima	1,2B	5,8
Central	Bangkok	1,2D,2B	5,4
	Kanchanaburi	1,2B	5
	Chacherngsao	2D,1,2B	5,7,8
	Chainat	1,2D,2B	2,5,7,8
	Cholburi	1,2B	5
	Nakhon Nayok	2A,1	2,7,5,8
	Nakornpathom	1,2B	
Central	Nonthaburi	1,2D	5,7,8
	Prachinburi	2A,2B,2C	1,5,7,8
	Ayudhaya	2A,2B	2,5,7,8
	Petchburi	1,2B,2D,2C	5,7,8
	Rajburi	1,2B,2A	1,2,5,7,8
	Lopburi	2B,2A,1,2C	1,2,5,7,8
	Saraburi	1,2B,2D	4,5,7
	Sing Buri	2B,2A,1,2D	2,5,7,8
	Supanburi	2D,1,2A,2B	5
	Angthong	2B,1,2D	2,7,8
Southern	Choomporn	1,2C	2,5,7,8
	Nakornsrithammaraj	2B,1	2,5,7,8
	Songkla	2B,1,2A,2C	2,5,7,8,9
	Suratthani	1,2B,2C	2,5,7,8
	Pattalung	1,2B,2C	2,5,7,8
	Pattani	1,2B,2C	2,5

*Main rice cultivation method
1. Transplanted
2. Direct seeding :
   A. under dry condition (Deepwater rice)
   B. under dry condition (Lowland rice)
   C. under dry condition (Upland rice)
   D. under wet condition (Pre-germinated direct-seeded rice)

**Habitats
1. Deepwater paddy field
2. Lowland paddy field
3. Upland rice field
4. Abondoned field
5. Roadside canal or ditch (with shallow water)
6. Roadside canal or ditch (with deep water)
7. Marsh
8. Swamp
9. Lake

Scanning Electron Microscopic Observations on Seed Coat of Mimosa pigra L.

Hidejiro Shibayama and Walapa Pornsuksawang (Botany and Weed Science Division, Department of Agriculture, Thailand)

This work was conducted to investigate what part of seed coat of M. pigra L. would be affected by dormancy-breaking factors and would result in the increase of water permeability.

Materials and methods

After various treatments for breaking dormancy mentioned in the previous report, vaselline was coated over the seed coat of M. pigra L. at the top end, middle part and base end of each seed (Figure 1). For each site of vaselline coating after various treatments, 20 seeds were used in one petri dish with [illegible] replications. Filter papers in dishes were wetted by distilled water. After 1 or 2 weeks of the imbibition, number of germinated seeds were counted.

The seed coat of M. pigra L. was observed by the Scanning electron microscope (SEM), AKASHI MINI SEM Alpha-9, after gold coating by Ion Coater IB-3 for 3 min.

Results and discussion

Vaselline coating experiment :

After six kinds of treatments, the seed coat of M. pigra was affected, and many of them began to imbibe, swell and germinate as mentioned in the previous report. However, when vaselline was coated over the top end, middle part and base end of each seed (Figure 1) after treatments, coated seeds revealed different abilities to absorb water and germinate. As in Figure 2, seeds treated by boiling hot water, alternating temperature, flame-burning and 99.5% acetone germinated a little or none, when their base ends were coated with vaselline, but those, of which middle parts or top ends were coated, germinated very well as uncoated seeds did. However, seeds treated by conc. H_2SO_4 and sand-scrubbing could germinate around a half of or the same as uncoated seeds, even when their base ends were coated with vaselline.

There are strophiole, hilum and micropyle tissues at the base end of seeds of M. pigra L. (Figure 1) So, treatments of boiling hot water, alternating temperature, flame-burning and 99.5% acetone, which induced the water imbibition through base ends, would be effective mainly to change the water permeability of these tissues. On the other hand, conc. H_2SO_4 and sand-scrubbing treatments seemed to cause the change of water permeability at any parts of seed coat.

Scanning electron microscopic (SEM) observations :

By boiling and low temperature treatments, there was little change at the top end and middle part of M. pigra seed comparing to untreated one (Figure 3). However, strophioles at base ends were frequently swollen and cracked after these treatments, which seemed to become sites of water entry to break dormancy (Figure 4,5). Any outer morphological change was not found at hilum or micropyle in this observation.

On the other hand, by conc. H_2SO_4 treatment, severe damages to the outer layer of seed coat were observed (Figure 6), in addition to the swelling and cracks of strophioles. These damages would be the reason of difference in the imbibition after various dormancy-breaking treatments and vaselline coating.

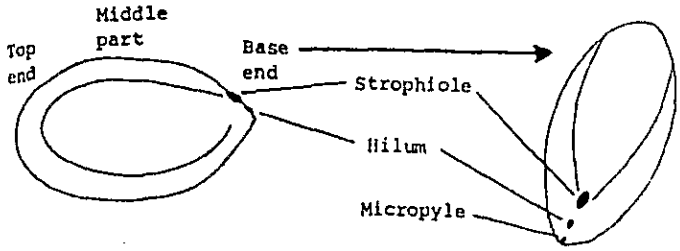


Figure 1. The top end, middle part and base end of seed of Mimosa pigra L. (left), and tissues at the base end (right).

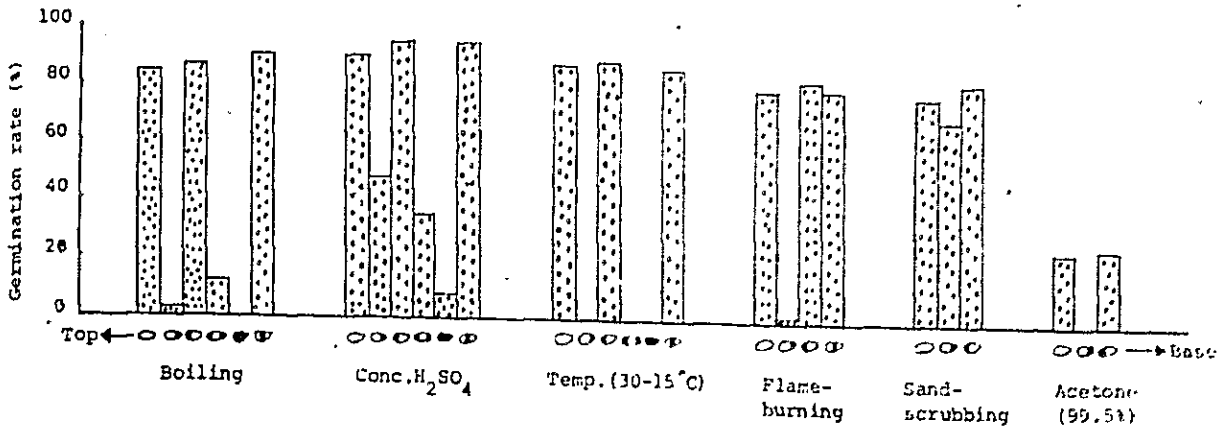


Figure 2. Effect of vaseline coating on seed germination. New seeds (collected in 1982) were used for these treatments except alternating temperature in which old seeds (collected in 1981) were used. Vaseline was coated at black portions. Left end of seed was the top, and right one was the base as in Figure 1.

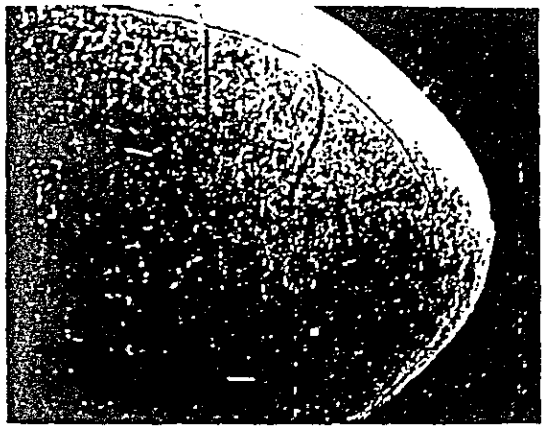


Figure 3. Surface of seed coat (by SEM).

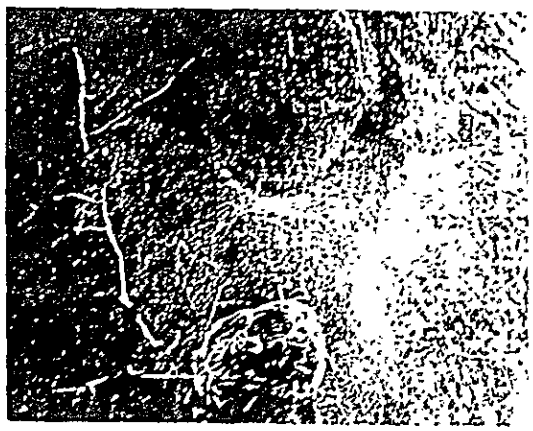


Figure 4. Strophiole and hilum of untreated seed (by SEM).

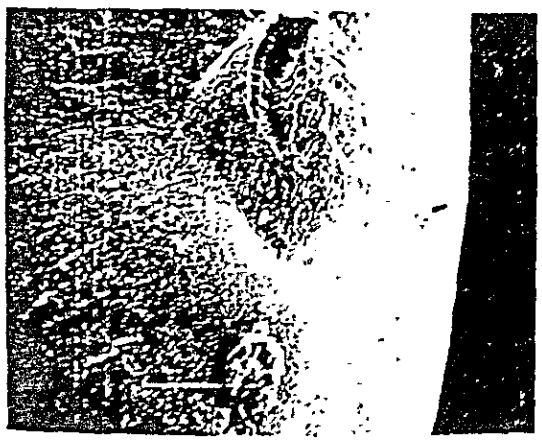


Figure 5. Strophiole and hilum of boiled seed (by SEM).

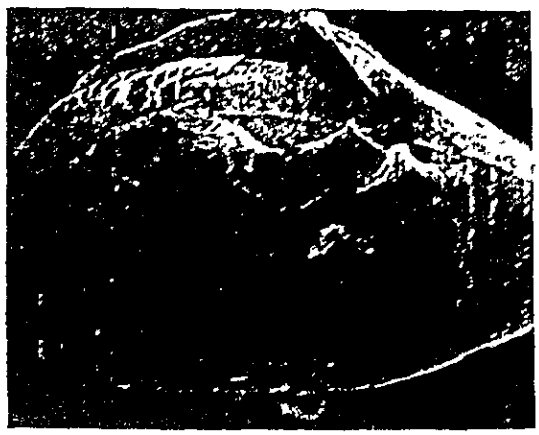


Figure 6. Conc. H_2SO_4 - treated seed (by SEM).

Effects of Temperature and Other Factors on Seed Germination of Mimosa pigra L

Hidejiro Shibayama and Walapa Pornsuksawang (Botany and Weed Science Division, Department of Agriculture, Thailand)

The control of Mimosa pigra L. by herbicides has been successfully tried by some Thai researchers. However, seed germination and establishment of this species will be also problem when we consider its infestations to new habitats or re-infestations after removal of the cover by chemical or mechanical methods. This work was conducted to investigate some biological characters of seed germination of M.pigra L.

Experiment 1. Effects of temperature on seed germination.

The experiment was done by incubator and hot water bath. Petri dishes with moistened filter paper were used for incubator experiment, and after 1 or 2 weeks' treatment, dishes were kept in room temperature condition during 2 weeks. In hot water bath experiment, test tubes were used for temperature treatment during 1 sec to 1 week and seeds were moved to petri dishes with filter paper and were kept in room temperature condition during 2 weeks.

In constant temperature experiment, hot water was effective for breaking dormancy of seeds and the germination rate was the higher as temperature was the higher up to 98 C (Figure 1 and 2). In each temperature, the germination rate increased, reached to the maximum and decreased again, as treatment time became the longer (Figure 1). Low temperatures as 5 and 10 C of incubator experiment were also very effective for breaking dormancy of seeds by 1 week treatment, but, as temperature was the higher than 10 C, the germination rate was the lower (Figure 2).

In alternating temperature experiment, 10 to 20 C difference of day and night temperatures treated during 1 or 2 weeks strikingly induced the awakening of seeds from dormancy. Especially, at day temperature 30 or 35 C, 15 C difference was nescessary to get the higher germination rate, but at day temperature 2' or less, even 10 C difference was enough to get the high germination rate. Moreover, old seeds collected in 1981 showed higher germination rate than new seeds collected in 1982, when they were tested in 198. (Figure 3).

Experiment 2. Effects of other treatments.

Light in day time (dark in night time) or dark in whole day did not cause any difference for seed germination. Seeds stored in water germinated more than those in air dry condition under alternating or constant temperatures (Figure 4).

Conc. H_2SO_4 and HCl were treated to dormant seeds during 0.5 to 10 min, and only conc. H_2SO_4 was found effective for breaking dormancy. Burning by flame and scrubbing by sand paper were also effective for breaking dormancy of seeds. Among organic chemicals, only 99.8% acetone was effective for breaking dormancy of weeds, but ohters, even 98% acetone did not have any effect (Figure 4).

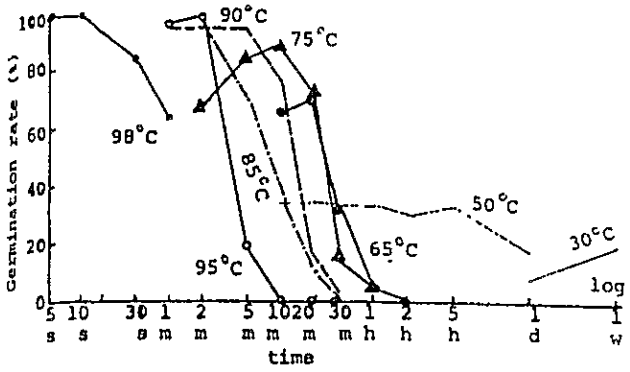


Figure 1. Effect of periods of constant temperature treatment by hot water bath on germination of 'old seeds' (collected in 1981) of M. pigra L. Experiment was conducted in August to October,1982. Seeds were moved to room temperature after treatment. s : second, m : minute, h : hour, d : day, w : week.

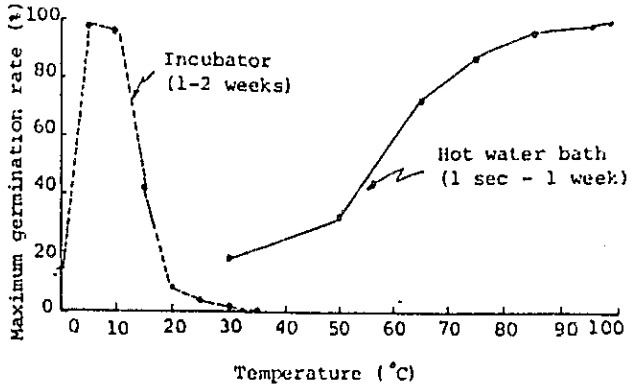


Figure 2. Effect of constant temperatures on maximum germination rate of 'old seeds' (collected in 1981) of M. pigra L. Experiment was conducted in August to October,1982. Seeds were moved to room temperature after treatment.

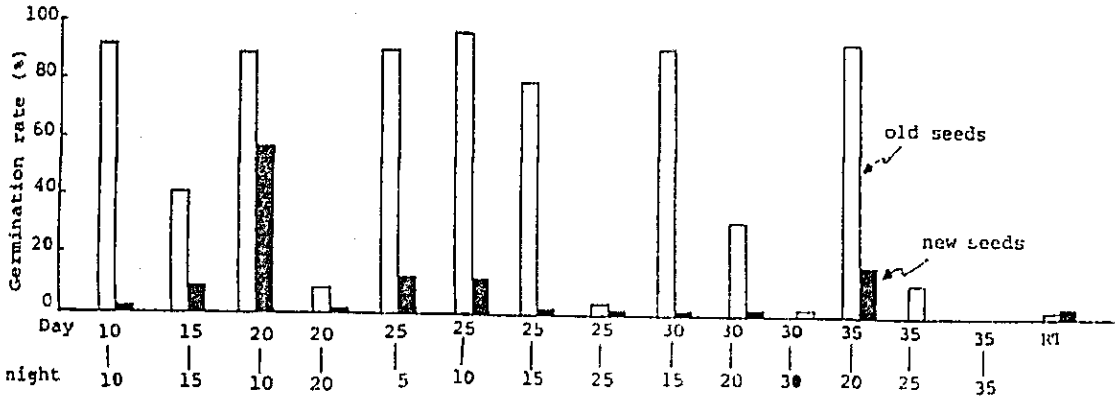


Figure 3. Effect of alternating temperatures on germination of old (collected in 1981) and nes (collected in 1982) seeds of M. pigra L. Experiment was conducted in August to Octoner, 1982. Temperatures were treated one or two (day temperature 25 C only) weeks, and then, seeds were moved to room temperature. Day : 6.00 a.m. - 6.00 p.m. (Light), Night : 6.00 p.m. - 6.00 a.m. (Dark), RT : Room temperature

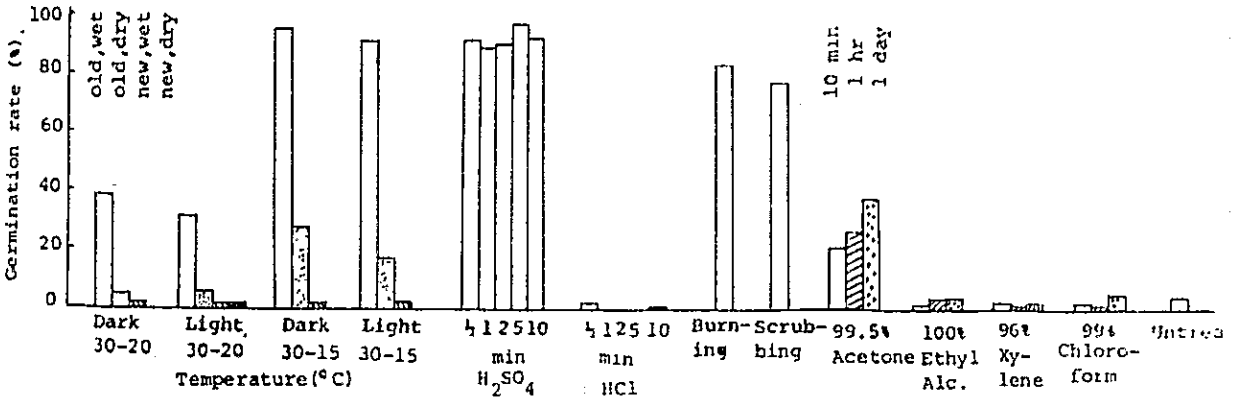


Figure 4. Effect of other treatments on seed germination of M. pigra L.

Light : day time (6.00 a.m. - 6.00 p.m.) only, and night time was dark
Dark : whole day dark
Wet : stored in water
Dry : stored in air-dry condition

Light experiment was conducted at 30-25 or 30-15 C alternating temperature. New seeds were used for experiments except light one in which old and new seeds were used.

Anatomical Effects of Herbicides and Flooding Water on Mimosa pigra L.

Hidejiro Shibayama and Kanika Pienpuck (Botany and Weed Science Division, Department of Agriculture, Thailand)

For controlling Mimosa pigra L., post-emergence herbicides were mainly applied to vegetations. So, one of objectives of this research is to investigate anatomical effects of glyphosate and 2,4-D amine salt on M. pigra shoots. Another one is to investigate anatomical structures of M. pigra roots which were grown under upland and water-flooded conditions, because the adaptability of them to both conditions would cause the infestation of M. pigra in aquatic and upland areas.

Materials and methods

This work was conducted from October of 1981 to February of 1983. M. pigra plants were grown in pots with paddy soil under flooded or upland condition. Glyphosate and 2,4-D amine salt solutions were sprayed to seedlings of 30 to 40 cm in height, at doses of 0.563, 1.125, 2.25 and 4.50 kg(ai)/ha. Treated leaves were collected almost on 1 day to 1 week after treatment and fixed in FAA solution.

In water-flooding experiment, seedlings were flooded by tap water after growing under upland condition for about one month. Flooded and untreated stems and roots were collected on 1 week to 2 months after treatment and fixed in FAA solution. Some materials were collected from natural vegetations of M. pigra at Kiu Lom dam reservoir, the Ping River and Chiangmai city, and were fixed in FAA solution.

All fixed materials were sectioned with sliding, freezing, or rotary (by paraffin method) microtome, stained with safranin and fast green and investigated by photomicroscope after regular microtechnique procedure.

Results and discussion

Herbicide treatment :

By treatments of glyphosate and 2,4-D amine salt, cytoplasm and plastids of palisade and sponge cells of leaves decreased strikingly, but there was little change on the structure of each cell (Figure 1,2,3,4). After leaf-burning by 2,4-D amine treatment, sometimes, leaves were observed to be shrunk. In the region of shoot apex, many cells of leaf primordia or other tissues were completely vacuolated by treatment. Within 2 or 3 weeks after herbicide treatment, damaged leaves usually became yellow and brown and then fell down on the ground. However, it was not clear in this study how glyphosate or 2,4-D would inhibit the growth of stem.

Water-flooding treatment :

Water-flooding treatment has caused the formation of spongy tissue from the periderm of bark of M. pigra roots. As primary tissues, epidermis and cortex were used to be crushed by the secondary growth stele in upland soil, but, in flooded soil or flooded water, they were still existing at early stage of the secondary growth. Cork cell layers were found in roots of flooded condition, but they were peeled off in those of upland condition (Figure 5,6,7,8). Morphological difference of roots in both conditions may show the physiological adaptation of Mimosa roots to aquatic and upland conditions. However, the mechanism

of adaptation was not cleared yet.

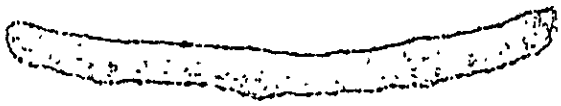


Figure 1. Untreated leaf

Figure 3. Leaf treated with glyphosate

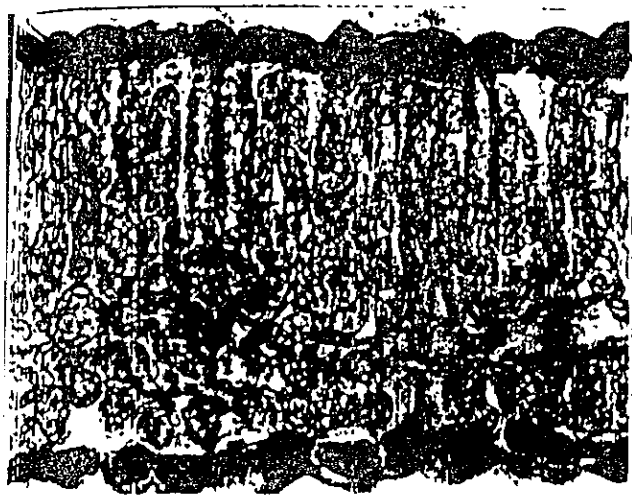


Figure 2. Untreated leaf

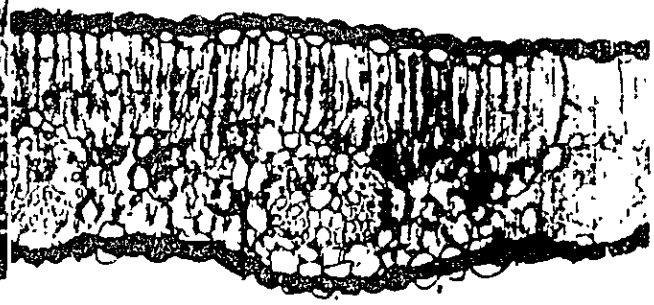


Figure 4. Leaf treated with 2,4-D amine salt

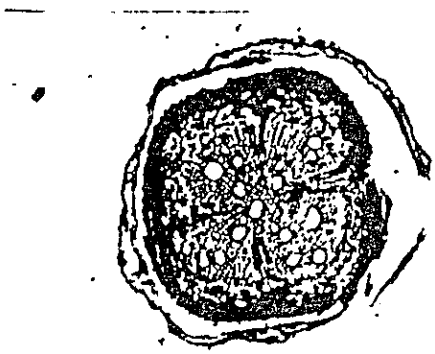


Figure 5. Root in upland soil

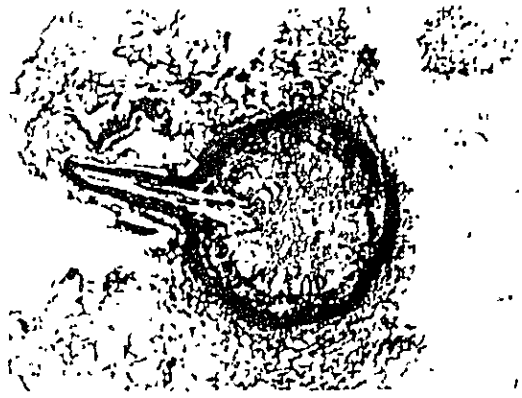


Figure 6. Root in flooded water

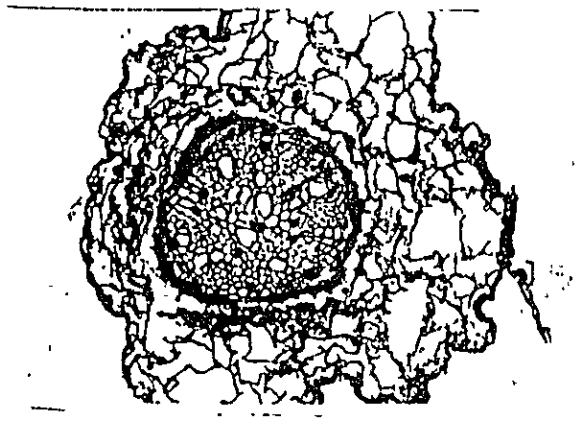


Figure 7. Secondary root in flooded soil

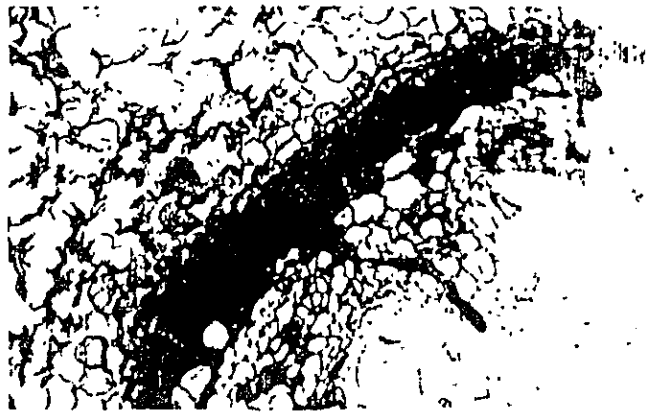


Figure 8. Cork tissue of root in flooded water

Some Observations for Identification of Marsilea crenata in Thailand

Chanpen Prakongwong and Kenji NODA

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ABSTRACT

Preface : Marsilea crenata, water clover, is one of the most serious weeds in paddy in not only Thailand but also other southeastern countries such as Indonesia, the Philippines and Malaysia. In Thailand, this weed has been recognized to be very difficult to control perfectly in paddy because it reproduces rapidly by the rhizomes as well as spores and the rhizomes have tolerance to several herbicides.

On the other hand, it has been known that another marselia species named M. quadrifolia has been distribution in Asian countries such as Japan, Taiwan and mainland China. Both species is very difficult to be discriminated at a glance and then some persons in Thailand have said that they are synonimous.

Further, Mr. Itaki has described that M. quadrifolia is distributing throughout Japan but M. crenata exists in a part of extremely southern Kyushu.

Thus, in order to make proper identification of M. crenata in Thailand, some experimental investigations have been performed from October of 1982 to March of 1983 as a cooperative work of NWSRI project in Thailand.

Results : Several ecological and physiological properties of M. crenata Bangkhen and M.quadrifolia were compared. 1) Difference in leaf color was measured by spectrophotometer as indicated Fig. 1. There is essential difference at around the range of spectrums refer to chlorophyl a and b, but exist at around spectrum from 390 λ to 350 λ. Absorption values of both samples were recorded at 370 λ as seen in the table of Fig. 1. 2) Difference in percent floating leaves was found between both species. When observed on the 16th day after transplanting in Experiment I, M. crenata (B) indicated almost zero percent in the rate of floating leaves, but M. quadrifolia (K) indicated 46.6 in percent floating leaves at the average of five replication. Further, their floatingness was observed under 3 and 7 cm in water depth as indicated Fig. 3. 3) Leaf area and shape were compared between both species. Leaf area of 25 leaves in cm^2 is shown by their distribution in Fig. 4. Those of M. crenata (B) provided distictly the distribution of relatively larger leaves.

In general, M. crenata (B) indicates frequently crenulate leaves as seen in photo , when compared with M. quadrifolia (K) in which there is hardly seen in this experiment. 4) Initial formation sporocarps in M. crenata (B) found around December but it in M. quadrifolia was in January, thus, estimated that M. crenata has earlier formation of sporocarp that does M. quadrifolia. Mutual relation of sporocarp formation and length and/or site of pedicel emergence are different between both species shown in Table 2. In general, Pedicels of M. crenata emerged from the base of petiole in a rhizome. Pedicels of M. quadrifolia emerged from a portion that is somewhat aparting from the base of a petiole in the rhizome and it branches, generally bears two sporocarps at its terminal site.

Further, the shape of a sporocarp formed is different between both species, as shown in Table and photo.

Fig. 1. Comparison on the Spectrum of Acetone-extract from Leaves between M. crenata and M. quadrifolia

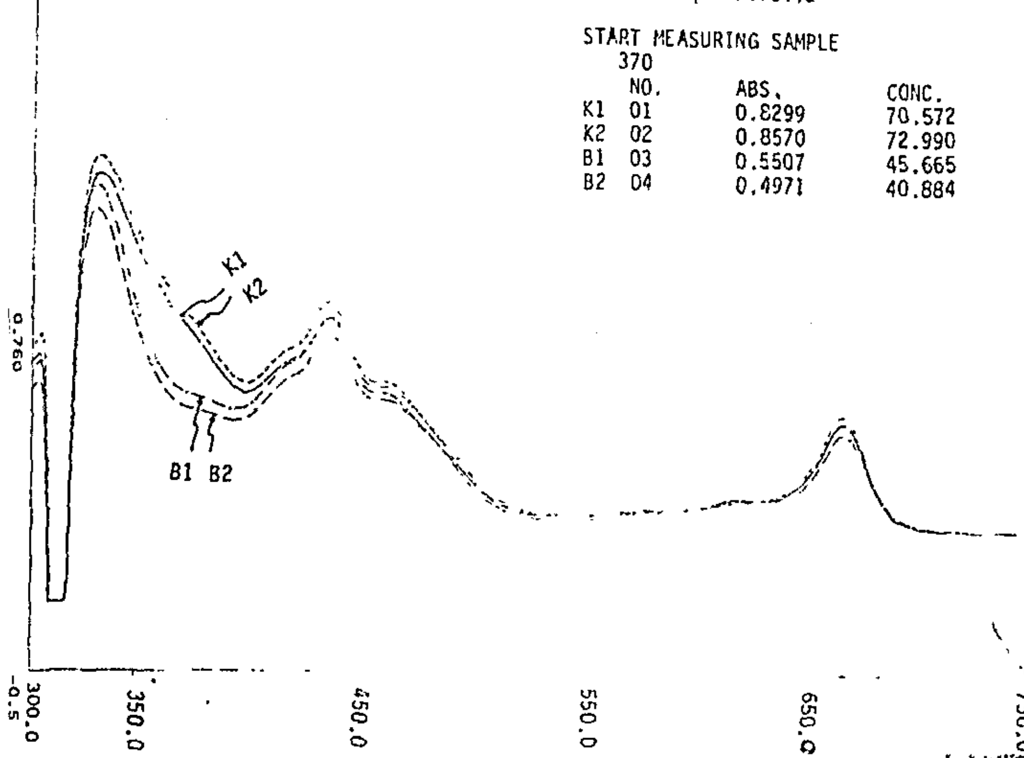

Table 2. Comparison of the Length and Site of Pedicel between M. crenata and M. quadrifolia

Item	M.crenata	M.quadrifolia
[illegible]	[illegible]	[illegible]

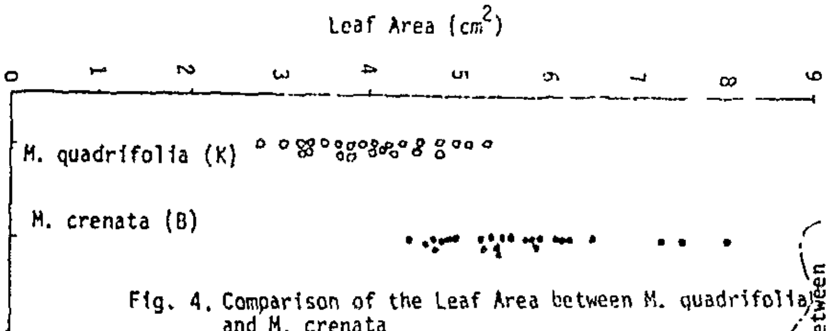

Fig. 4. Comparison of the Leaf Area between M. quadrifolia and M. crenata
Note: Expanded adult leaves

Table 1. Comparison of the Sporocarp Formation between M.crenata (Bangkok) and M.quadrifolia (Kyushu)

Item			M.crenata (B)	M.quadrifolia (K)
Size of Sporocarp	Thickness	mm.	2.21 (1.8 - 2.9)	2.95 (2.7 - 3.1)
	Width (a)	mm.	3.25 (3.0 - 3.4)	3.16 (3.0 - 3.6)
	Length (b)	mm.	3.81 (3.3 - 4.2)	4.21 (3.8 - 4.7)
b/a		( )	117.[illegible]	133.2
Appearance			[illegible]	ellipse [illegible]

Note: [illegible]

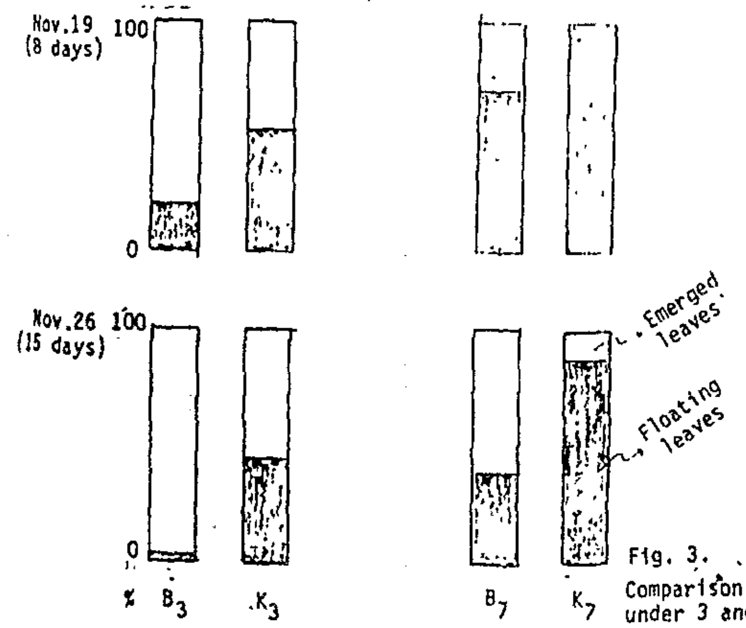

Fig. 3. Comparison of Floating and Emerged Leaves under 3 and 7 cm in Water Depth between Both Marsilea
B: M.crenata (Bangkok), K: M.quadrifolia (Kyushu)

タイ国の雑草問題と日・タイ雑草研究プロジェクトの紹介

日・タイ雑草研究プロジェクト，タイ農業局　野田健児，マニサ・テラワッサクール

Weed Problems in Thailand and Introduction of National Weed Science Research Institute Project

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(NWSRI Project, DOA, Thailand)

(Weed Res. Japan Vol. 27, 55-60, 1982)

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タイ国の雑草問題と日・タイ雑草研究プロジェクトの紹介

日・タイ雑草研究プロジェクト，タイ農業局　野田健児，マニサ・テラワッサクール

ま え が き

タイ国の農業生産の発展は，これまで数次の5年計画を通して，耕地の増加に主指向され，総生産量においては各作物ともかなりの成果を収めてきた。しかし，単位面積当りの収量は必ずしも増加していない。作物によってはむしろ不適地に作付されることによって減収しているものも見られる。従って，今後の作物生産にとって，減収阻害要因を除くことが極めて重要と考えられ，その一要因として雑草も大きく取上げられて来た。また他方，雑草は耕地のみでなく水域や非農耕地において環境破壊要因として作用する場面も多く，この様な現状から，これまでその技術および基礎研究の著しく遅れていた雑草研究の発展を意図して，1979年わが国に対して「雑草科学研究所プロジェクト」(National Weed Science Research Institute Project, いわゆる NWSRI project) の要請があり，1980年にこのプロジェクトが発足し，現在に至っている。ここに，タイ国のかかえている雑草問題及び本プロジェクトの概要を紹介する*。

タイの主要雑草

タイは東南アジア大陸部の熱帯地域に位置し，国土面積51.4万km²，わが国の1.4倍を占める。地理的には大陸部と半島部に分けられるが，さらに地勢，土壌，気象，農業・作物生産条件の点から数地区に分けられ[1,2]，それに伴って主要雑草の分布も左右されるものと考えられる。タイの主要雑草は広葉，イイ科，その他多岐にわたり，温帯である日本とはかなり異っている。Table 1～3には地目ごとに代表的雑草種をあげた。これらの中，2，3の特色をのべると，水田においてタイヌビエは日本やその他におけるほど大きな問題でなく，むしろ *Echinochloa colonum* が多発して問題である。直播水稲では *Oryza* spp.，(野生イネ)，*Leptochloa chinensis* (アゼガヤ)，*Leersia hexandra* の多発がみられる。また，広葉では2,4-Dに抵抗性のあるといわれる*Sphenoclea zeylanica* や二期作水稲に多い *Marsilea crenata* などが防除困難な雑草として上げられる。

畑作においても雑草の種類は多い。うち，*Pennisetum pedicellatum* および *P. polystachyon* は communist grassといわれ，全国に分布している。*Cyperus rotundus* (ハマスゲ)，*Echinochloa colonum*，*Cynodon dactylon* (ギョウギシバ)，*Eleusine indica* (オヒシバ)，などが強害草として上げられる。また，*Euphorbia geniculata*は広葉の中では分布域が最も広いようである。分布は未だ多くないが，特殊なものとして寄生性雑草 *Striga asiatica* はトウモロコシ地帯に分布する。

非農耕地雑草としては北タイの河川，貯水池に沿って急速に繁茂してきた *Mimosa pigra*，タイ全土の池，沼に広く分布する *Eichhornia crassipes* (ホテイアオイ)，前記 *Pennisetum* spp などが代表的なものとして上げられる。

これら各種雑草の個性態・生理については未だ不明のものが多く，今後の研究に期待される。

雑草害と雑草防除法

雑草の被害の第1は作物の収量減であり，タイの農業において100万ha以上といわれる直播水稲の雑草害は50%以上の収量減が推定される。また，大規模栽培でしかも低草丈作物である大豆，緑豆，落花生などの雑草害が畑作では大きい。また，そさい栽培では多収を目的として，多肥・多密栽培すれば雑草問題は深刻であり，多労経費をさけて除草剤もかなり使われている。管理不良のゴム園における雑草は幼木期の採ラテックス時期をおくらせ，成木園では収量を30～40%低下させるといわれる，適切な管理がなされているゴム園は全体の10%位にすぎない といわれている。

具体的な防除法として水田移植水稲では，深水による雑草抑圧が主体であり，除草剤の使用はすくない。直播水稲では初期雑草の除去には，適時，十分な人力を得るのが不可能であり，雑草との競争害を前提とした栽培が行われている。従って，2,4-Dなどの除草剤への期待が大きく，一部では使用されているが，安定的な効果には至っていない。

畑作においても耕耘，人力小器具除草が主体であるが，

* 詳細については文献1,2,3を参照されたい。

Table 1 Common Weeds in Paddy in Thailand

Scientific name	Common name	Thai name
Aeschynomene aspera Linn	—	Sano khaang khok
A. indica Linn.	indian jointvetch	Sano haangkai
Chara zeylanica Linn	—	Mafai nok khum
Cyanotis axillaris K I ex. Willd.	chara	Krachao naa
Cyperus difformis (L.) D Don.	—	Phak plaap naa
C. iria Linn.	rice flatsedge	Yaa rangkaa khaao
C. procerus Rotth	—	Yaa ta krap
C. pulcherrimus Willd. ex Kunth.	—	Kok lek
C. rotundus Linn.	purple nutsedge	Yaa haeo muu
Echinochloa colonum (L.) Link	junglerice	Yaa khaao nok
E. crusgalli (L.) Beauv.	barnyardgrass	Yaa plong lemaan
Eclipta alba (L.) Hassk	yerba-de-tago	Kameng
Eleocharis dulcis (Burm. f.) Honchel.	—	Haeo song krathiam
Fimbristylis dichotoma (L.)	—	Yaa niu nuu
F. miliacea Vahl	—	Yaa rat khiat
Fuirena ciliaris (Linn) Roxb.	—	Yaa khom baang klom
Ipomoea aquatica Forsk	swamp morningglory	Phak bung
I. rugosum Sahsb.	—	Yaa daeng
Jussiaea linifolia Vahl	water primrose	Thian naa
J. repens Linn	creeping water primrose	Phak phaeng phuai
Leersia hexandra Sw.	southern cutgrass	Yaa sai
Leptochloa chinensis Nees	—	Yaa yon huu
Marsilea crenata Presl.	water clover	Phak waen
Melochia corchorifolia L.	redwood	Seng lek
Merremia hederacea (Burm) Hallierf.	—	Thao sa uek
Monochoria vaginalis (Burm. f.) Presl.	—	Ninlabon
Oryza spp.	—	Yaa khaao thaam
Paspalum scorbiculatum Linn.	—	Yaa plong hin
Pentapetes phoenicea L.	—	Baan thiang
Rotala indica (Willd) Koehne	—	Huai chinnasee
Scirpus articulatus Linn	bulrush	Songrathiam huawean
S. grossus Linn. f.	—	Kok saamliam
Sphenoclea zeylanica Gaertn.	goose weed	Phak pot
Utricularia aurea Lour.	—	Saarai khaao nieo
Xyris indica Linn.	—	Kra thin naa

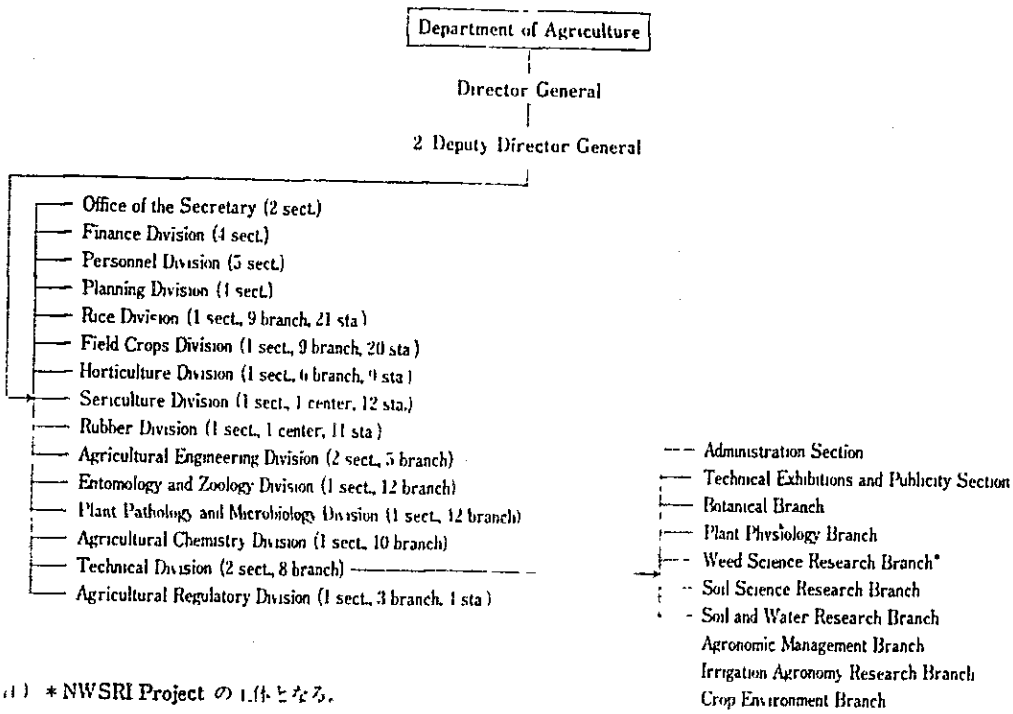
Table 2. Common Weeds in Upland Crops in Thailand

Scientific name	Common name	Thai name
Amaranthus viridis Linn	Slender amaranth	Phak khom pat
Brachiaria reptans (Linn.) Gards & Hubb		Yaa ton tit
Cynodon dactylon (L.) Pers	Bermuda grass	Yaa phrack
Cyperus iria Linn	Rice flatsedge	Yaa rangkaa khaao
C. rotundus Linn	Purple nutsedge	Yaa haeo muu
Dactyloctenium aegyptium (L.) P. Beauv.	Crowfootgrass	Yaa paak khwai
Digitaria adscendens (HBK) Henr.		Yaa plong khaao nok
Echinochloa colonum (Linn.) Link	Junglerice	Yaa khaao nok
Eleusine indica (Linn.) Gaertn	Goose grass	Yaa teenkaa
Euphorbia geniculata Orteg.		Yaa yaang
Leptochloa chinensis (Linn.) Nees	-	Yaa you huu
Pennisetum pedicellatum Trin	—	Yaa khachon chop
P. polystachyon Schult.		Yaa khachon chop
Portulaca oleracea L.	Common purslane	Phak bia yai
Striga asiatica (L.) Kuntze	Witchweed	Yaa mae mot

Table 3 Weeds in Non—Cultivated Lands in Thailand

Scientific name	Common name	Thai name
Aeschynomene americana L.		Sano don
Brachiaria mutica Stapf	Signalgrass	Yaa khon
Eichhornia crassipes (Mart.) Solms	Water hyacinth	Pak taop chava
Eupatorium odoratum Linn.		Saap suea
Hydrilla verticellata		Saaraai haang krarok
Imperata cylindrica Beauv	Cogongrass, Lalanggrass	Yaa khaa
Mimosa pigra Linn.		Maiyaraap Yaak
Mucuna pruriens DC.		Maa mui
Pennisetum pedicellatum Trin.		Yaa khachon chop
P. polystachyon Schult.		Yaa khachon chop
P. purpureum Schumch	Napier Grass, Elephant Grass	Yaa nepia

Table 4. Present Organization of Agriculture Department, and Future Structure of the NWSRI Expected



(1) *NWSRI Project の主体となる。

規模が大きくなると，適切な除草手段が得られない場合が多いようである。

また，多収・施肥技術の進んだ作物では除草剤への依存が高まりつつあり，バンコック近郊では，そさいの除草には人力によるよりも除草剤による方が経済的ともいわれている。しかし他面，平担地では池や河川は重要な漁業源であり，除草剤の普及には毒性の点で慎重にならねばならないようである。

雑草研究組織（プロジェクトの背景）

タイ国農業局内における雑草研究は第4表に示したように，技術部雑草科が当ってきた。従って，本プロジェクトは雑草科を主体として開始されたものである。現在の研究員17名*は他の作物保護部門である植物病理および害虫部が200名のスタッフを擁するのに比べれば極めて弱体であり，しかもこれらの雑草科のスタッフは他部門の専攻で雑草研究の経験があるものは極めて少なく，

* 1981年12月，20名に増員。

また若い。加えて，研究装備も極めて貧弱である。なお，タイ国内においては農業局以外に体制的な雑草研究は行われていない。属人的にカセサート大学農学部及び理学部，チラロンユン大学理学部，チェンマイ大学農学部などにおいて研究・調査が行われている。これらを横につなぐ情報交換機関としては Weed Science Club of Thailand が数年前組織されたが，現在は有名無実となっており，その再組織化の必要性をとく人もある。

以上の様な状況からタイ農業局より1979年日本に対して「雑草科学研究所プロジェクト」(National Weed Science Research Institute Project, NWSRI Project) の要請があった。日本（国際協力事業団）は，事前調査（2～3月，1979），長期調査（1～3月，1980），実施協議調査（R/D交換）（4月，1980）を経て，1980年9月より専門家派遣により本プロジェクトを発足させた。

プロジェクトの内容

本プロジェクトの要請は研究レベルの格上げと共に，当初は普及機能も考えたかなりぼう大な grant-aid の要請もなされたが，この grant-aid は時期尚早，内容不分明の点から正式な受理はなされてなく，現在は研究レベルの格上げ及び共同研究・教育を目的とした次の3条項が主体となっている。すなわち，1) 専門家の派遣。長期及び短期雑草専門家，または目的に応じた他の専門家が現地においてタイの研究者と共同研究，または研究指導を行うものである。2) 研究・試験用機材の供与。研究費の少ないタイ等開発途上国ではいずれも同様な条件であるが，専門的な研究装備は極めて貧弱である。プロジェクトの大きなメリットであり，しかもプロジェクト終了後も現地国によって維持管理が可能である必要なものを供与する。3) 研究員（タイ）の研修。タイ側の推せんしてくるタイ研究員をわが国の関係機関において専門的な研修を行うものである。年3ないし5名位が期待される。現在，雑草生物学，雑草防除，除草剤の3つに区別して，研修が計画（一部実施）されている。

Table 5. Master Plan of Cooperative Work (JICA/NWSRI Project)

Project management ··· General research management

Research work

1. Identification and distribution of weeds in Thailand
2. Biological characteristics of principal weeds
   1) Gramineous weeds
   2) Broadleaf weeds
   3) Aquatic weeds
   4) Cyperaceae weeds
3. Weed control/management and yield losses
   1) Direct-seeded rice
   2) Field crops
   3) Transplanted rice
4. Biology and control of non-agricultural weeds
5. Herbicides
   1) Herbicide evaluation
   2) Herbicide physiology
   3) Herbicide residue
6. Others

Planned according to the necessity to be arisen

研究内容のマスタープラン

本プロジェクトはタイにおける雑草研究分野の水準向上ということが主目的であり，従って研究範囲は広く，基礎研究から応用技術研究までカバーしなければならない。第5表にはプロジェクトが包含する大，中課題をリストアップした。

研究課題1。先づ，全タイにおける主要雑草の分布様相，およびその分布を支配する要因の解析をも行うことが大切である。このためには，長期的に日本の専門家とタイ側カウンターパートとの協力体制が必要である。

研究課題2は合理的な防除のための基礎であり，系統ごとに主要雑草を抽出して実験研究が行われると共に系統をこみにした生物学的特徴の解明も研究の対象となり得る。

研究課題3についてはすでにタイ側の研究者によって行われてきている。プロジェクトとしては水稲，畑作を主として取扱うこととなっている。

研究課題4の非農耕地雑草については，先ず本project要請の大きな背景ともなった *Mimosa pigra* などが取上げられる。これらについては潜在的な利用性も考えながら進めるべきであろう。

研究課題5の除草剤は，防除法の一部であるが，タイにおいても研究者，農家とも大きな関心事であり，少ないながら急激に増加しつつあるので，大きな一つの対象として設けられた。細別して，除草剤の評価試験はすでに圃場レベルにおいてタイの研究者によって実施されてきている。除草剤の生理，除草剤の残留性については供与機材を有効に使用することによって，プロジェクトでの成果が期待される。

研究課題6にはその他本プロジェクトの進展に伴って他専門の知見に基づいた研究課題が含まれるであろう。とくに雑草防除の最終目的が総合防除であるとき，その技術開発のための基礎および応用技術が考えられて

くる。例えばタイの土壌，農業条件に適合した機械除草機の開発，生物的防除の可能性と限界，さらに生態的防除とくに作付体系による防除の限界などである。さらに，得られた研究成果の普及場面への適用のために特に重要な項目としては，得られた防除技術の社会経済的評価の研究が望まれる。

むすび

すでに発足している国際協力事業団による日・タイ雑草科学研究プロジェクトの紹介，およびその背景となっているタイの雑草問題を概説した。このプロジェクトの意図するところは，恒久的な雑草研究，技術の水準の向上にあると共に緊急に協同研究によって解決すべき点も多い。

プロジェクトの成功には研究装備の充実が必要なことはいうまでもないが，それを動かすのは人間である。今後とも日本雑草学会の協力に待つところ多く，この文が多くの人のプロジェクト理解の資となれば幸いである。

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Weed Problems in Thailand and Introduction of National Weed Science Research Institute Project

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Summary

National Weed Science Research Institute Project has been started in September, 1980 in Thailand sponsored by Japan International Cooperation Agency (JICA) This project is derived from the seriousness of weed problems in agricultural as well as non-agricultural situations in Thailand at present.

In order to learn its necessity, the Preliminary Survey in February to March 1979, the Long-term Survey in January to February 1980 and the Implementation Survey for Record of Discussion in April 1980 were performed by JICA.

In this paper, the outlines of weed problems in Thailand and of project performance have been introduced.

1 Principal weed species in Thailand are listed in Tables 1 to 3 in respective paddy, upland and non-agricultural sectors They are considerably different from those in Japan, and some of them should be laid special stress on control in actual fields and then be employed mainly in research in the coming time.

2 The greatest damage due to weeds is yield losses of crops, particularly in direct-seeded rice, lower planted and/or large scaled crops such as soybeans, mungbeans and peanuts, and intensively cultivated vegetables. Further, small scaled rubber has given severely reduced latex yield due to weeds and woody plants Further, specific weeds have provided hazardous effects in agricultural operation, useful animals and human kind in fields and so on.

3. Main methods of weed control in Thailand are composed of water control in paddy and hand weeding by small tools in upland. Herbicide application is now less, but it seems to increase very much if effective herbicides are developed because farmers have strong interest in it.

4. National Weed Science Research Project (NWSRI project) has been started in September, 1980 in order to solve urgent weed problems but also to make permanently upgrading of weed science research activity in Thailand because of its backwardness compared with plant pathology and entomology in the plant protection field.

5. The project involves three kinds of activity: 1) Dispatch of long- and short-term experts from Japan 2) Supply of equipment and/or machinery necessary to do cooperative work in Thailand 3) Training of counterparts in appropriate organizations of Japan.