# 芝山秀次郎専門家研究論文

PROJECT REPORT NO. 1

# HABITATS, SEED GERMINATION AND ESTABLISHMENT OF *MIMOSA PIGRA* L. AND SOME EFFECTS OF HERBICIDES

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**NATIONAL WEED SCIENCE RESEARCH INSTITUTE PROJECT**
by
Japan International Cooperation Agency, JAPAN
and
Department of Agriculture,
Ministry of Agriculture and Cooperatives, Thailand

March 25th, 1983

*(UNPUBLISHED)*

# Habitats, Seed Germination and Establishment of *Mimosa pigra* L. and Some Fffects of Herbicides

By the cooperative research work between Thailand and Japan, under the National Weed Science Research Institute (NWSRI) Project of Japan International Cooperation Agency (JICA)


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## On the Occasion of Distributing the Project Report No. 1

The National Weed Science Research Institute Project (NWSRI Project) in Thailand, sponsored by the Japan International Cooperation Agency, has been already made implementation through three project categories ; that is, joint research works of urgent weed problems existing in Thailand by cooperation of Thai researchers and Japanese experts, supply and setting up of equipment and machinery to be necessary to do basic and applied research works, and training of Thai researchers (counterparts) in Japan in order to broaden the knowledges of Weed Science as well as to acquire the operation procedures of equipment supplied for about two and half years since September, 1980.

As a result of several kinds of research findings has been so far achieved from the joint works. The results should be distributed to the personnel of the Department of Agriculture as well as of other organizations, we think.

In an opportunity of leaving Thailand of Dr. H. Shibayama, a long term expert, after finalizing his assignment, The Project Report No.1 has been compiled by him. It involves research findings on the biology of Mimosa pigra L. as a basis of its control, which has been jointly conducted by his counterparts ; Dr. Paitoon Kittipong, Mrs. Cha-um Premasthira, Mrs. Kanika Pienpuck, Mr. Tawee Sangtong and Mr. Chaiyote Supatanakul, and himself. It is a great pleasure and grateful if any comments and criticism would be with them.

Finally, on the behalf of Japanese Experts I would say that adequate arrangement and cordial hospitality given to Dr. H. Shibayama from all of the Authorities and Staff of the Department of Agriculture and other personnel allied should be sincerely appreciated. Further, enthusiastic efforts of the above-mentioned counterpart staff to do joint works would be also with my heartfelt gratitude.

March 25th, 1983

Kenji NODA, Leader

NWSRI Project

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# PREFACE

The National Weed Science Research Institute (hereinafter referred to as NWSRI) Project by the Japan International Cooperation Agency (hereinafter referred to as JICA) had started on April 18th, 1980, under the Report of Discussion between Thai and Japanese Governments. Purposes of this project were the supply of machinery and research equipments, the training of Thai researchers in Japan and the cooperative research works by JICA experts and Thai counterparts. The location of this project is the Weed Science and Weed Control Branches of Botany and Weed Science Division (formerly, Weed Science Branch of Technical Division), Department of Agriculture, Ministry of Agriculture and Cooperatives, Royal Thai Government, at Bangkhen, Bangkok 10900.

The first author, Hidejiro SHIBAYAMA, was dispatched from Japan to Thailand on February 6th, 1981, as the long-term expert on weed biology of JICA/NWSRI Project, and stayed there about two years and two months until March 30th, 1983. During the period, he was assigned to have the cooperative research work on Mimosa pigra L. with Thai counterparts, because this species was considered to be one of the most serious weeds in Thailand. When he started the work on Mimosa pigra L., many Thai and an American scientists, from Department of Agriculture, Royal Irrigation Department, Kasetsart University, Chulalongkorn University, Chiangmai University and others, were already conducting interesting researches about biology, chemical and biological control, economy, or other aspects of Mimosa pigra L., under the Committee on Mimosa pigra of Ministry of Agriculture and Cooperatives, or independently. Consequently, almost his

efforts were concentrated on the following study, avoiding the overlapping of his work with those of other scientists, that was, "Habitats, seed germination and establishment of Mimosa pigra L. and some effects of herbicides". Because authors wished to have a contribution to the project on control of Mimosa pigra L. by the Ministry of Agriculture and Cooperatives, they reported almost all results of this study at the 2nd and 3rd meeting on Mimosa pigra L. by the Committee which were held on December 16th to 18th, 1981, and on March 16th to 18th, 1983, respectively, at Chiangmai city.

We would be very happy if this study might have something interesting for those officials and scientists who were participating in the project of Mimosa pigra L. control.

March 30th, 1983

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ACKNOWLEDGEMENTS

Authors would like to express our sincere appreciation to Mr. Yookti Sarikaphuti, Director General, Mr. Phaderm Titatarn, the former Director General, Dr. Riksh Syamananda, Dr. Tanongchit Wongsiri, Dr. Ampol Senanarong, Deputy Director Generals, Dr. Winit Changsri, the former Director of Botany and Weed Science Division (formerly, Technical Division) of Department of Agriculture, for their administrative support and encouragement.

Authors also wish to thank greatly Miss Umpai Yongboonkirt, Chief of Botany Branch, Miss Maneesa Teerawatsakhul, Chief of Weed Control Branch, all research, Office and field staffs of Weed Science and Weed Control Branches of Botany and Weed Science Division, for their valuable and friendly assistance and instruction.

Research assistant cooperation of Miss Walapa Pornsuksawang, were so great that this study would not have been possible without her.

Authors are indebted to Dr. Somphot Suwanwaong, the former Deputy Director General of Department of Agriculture and the senior researcher of Soil Chemistry and Fertility Branch, Mr. Visut Chandrangsu, Director of Botany and Weed Science Division and the former Chief of Crop Environment Branch, for their kind assistance and discussion.

Especially, the first author would like to appreciate to Mr. Kangwan Devahastin, Deputy Undersecretary of State and the Chairman of the Committee

on Mimosa pigra, Ministry of Agriculture and Cooperatives, Mr. Montri Rumakhom, Director of Entomology and Zoology Division of Department of Agriculture and the Chairman of Working Committee on Mimosa pigra, and other members of both Committees, for giving him the chance to attend the annual meetings of the Committee to present authors' reports.

Thanks are extended to Dr. Suvit Vibulsresth, Director, and other staffs of Remote Sensing Division, National Research Council, Dr. Iwao Nakajima, Director, Dr. Ohnuki and Dr. Sawada, Laboratory Chief and Researcher, Forestry Management Division of National Forestry Experiment Station, Ministry of Agriculture, Forestry and Fisheries, Japan, for their kind cooperation to let authors use the data of Satellite "Landsat", or to take colour pictures of computer analyzed data of "Landsat".

Authors are very grateful to Dr. Kenji Noda, Team Leader, and Mr. Hiroshi Hyakutake, the expert of NWSRI Project of JICA, Dr. Kiyoshi Torii, the expert of JICA Project at Chulalongkorn University, and Dr. Takahiro Inoue, the expert of Tropical Agricultural Research Center (TARC), for their useful advices and suggestions. Many thanks are due to Mrs. Yupin Kittipong and Miss Bussaba Phanpanich, secretaries of NWSRI Project for their helpful assistance, to Mr. Yukihisa Ishizuka and Mr. Kenichi Kawakami, JICA staffs of Tokyo and Bangkok Offices, respectively, for their useful and timely support.

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# I. GENERAL INTRODUCTION

Mimosa pigra L. is the thorny and sensitive leguminous shrub species, which was introduced into Thailand in 1947 as one of leguminous cover crops from Indonesia (16)(25), "Giant mimosa" is frequently used as the English common name of this species, but it was not accepted by some scientists yet, because there were several other local names like "catclaw", "giant sensitive plant", "maiyarap vak" in Thai, and so on (10)(13)(16)(17)(20).

In recent years, Mimosa pigra became one of the most serious noxious weeds, especially in aquatic areas of Northern Thailand. Moreover, this species has been feared to invade many areas in Burma, Laos, Vietnam and Cambodia along the Khong River, and to be an internationally noxious weed.

The vegetation of Mimosa pigra in aquatic areas has caused the serious concern about the disturbance of water flow in rivers and dam reservoirs by its stands in water and the decrease of the volume of reserved water. On the other hand, around Chiangmai city, which was the second largest city in Thailand after Bangkok and is internationally popular spot for tourists, Mimosa pigra plants were invading waste paddy fields or roadsides and made thick vegetations there. By the shrubby and the thorny character of all stems, branches and petiols, Mimosa pigra made these lands more useless and uncomfortable as the scenery. Land owners of these waste fields were said to live mainly in Bangkok and they did not care about the weed management of their lands.

So far, Ministry of Agriculture and Cooperatives (MOAC) set up the

Committee to control Mimosa pigra under its Minister in 1980, and many officials and researchers of Thailand from Ministry's administrative office, Department of Agriculture (DOA), Department of Extension (DOE), Royal Irrigation Department (RID), Electricity Generating Authority of Thailand (EGAT), Chiangmai University, Chulalongkorn University, Kasetsart University and private companies joined meetings of its Working Committee.

This study was conducted to have a contribution at meetings with investigations about some biological characters of Mimosa pigra and effects of herbicides on its seed germination, leaf anatomy and others.

# II. DISTRIBUTION AND HABITATS OF MIMOSA PIGRA L. IN AQUATIC AND OTHER AREAS OF THAILAND

Hidejiro SHIBAYAMA, Paitoon KITTIPONG, Tawee SANGTONG,
Chaiyote SUPATANAKUL and Cha-um PREMASTHIRA

## 1. Introduction

Distribution of Mimosa pigra was investigated world-widely by Habeck, Harley and others, and was reported to be at Texas, Central and South America, Central Africa, Southeast Asia, Northern Australia and some other countries (6) (7) (10) (13) (16) (27). Among these areas, Central and South America were considered to be the origin of the distribution of this species. However, the most seriously inhabited countries with Mimosa pigra are currently Thailand and Australia.

About the Mimosa pigra distribution in Thailand, Thamasara, S. of Royal Irrigation Department, Napompeth, B. of National Biological Control Research Center, Kasetsart University and Robert of IPPE, had collected interesting informations from local people and reported them mainly as provincial basis (12) (16) (17). Roberts cited the detailed map of Mimosa distribution precisely around Chiangmai city (16). By these informations, many officials are warning about its invasion into the downstream of the Chao Phraya River, especially, Bangkok metropolitan area. Furthermore, they are afraid that Mimosa pigra will infest the downstream of the Khong River into Laos, Cambodia and Vietnam. In order to investigate these possibilities, it was necessary to survey its habitats, not in provincial basis, but in each vegetation basis, because usually newly naturalized weed species

could spread quickly in new environmental conditions but later their distribution would be restricted by ecological limitation. This work was conducted to investigate the habitats of Mimosa pigra and its potential to spread out.

2. Methods

Distribution of Mimosa pigra vegetation and its habitats were surveyed groundly mainly in March to November, 1981, but it was continued until March of 1983. When survey were conducted along aquatic areas, its distribution between surveyed spots was estimated and included in the survey results as it was impossible to observe all Mimosa pigra vegetations because usually there were few roads to survey along aquatic areas.

Around and in Bangkok city, several spots were reported to grow Mimosa pigra plants (12) but these were only small number of plants instead of vegetation. So, they were excluded because they were consider not to be established as a vegetation and sometimes they were eradicated by hand-cutting or herbicide treatment.

The datum of Satellite "Landsat" which covered the Kiu Lom Dam Reservoir area on March 2, 1980, was analyzed by the computer of National Forestry Experiment Station, Ministry of Agriculture, Forestry and Fisheries, Japan, to show the modified colour picture of the area.

3. Result and discussion

As having been reported by some researchers (8)(12)(16)(17)(22)(25), Mimosa pigra vegetations were found mainly in the Northern Region of Thailand in these surveys. They were also found much along the Ping or the Chao Phraya River down to near Nakorn Sawan, several spots in the Nan or the Yom Rivers and in Saraburi and Nakorn Nayok Provinces, etc. (Figure II-1).

In Chiangmai Province, dense vegetations of Mimosa pigra were distributed along the Ing and the Warn Rivers, the Kok and the Lao Rivers, the Kham and the Chan Rivers, the Ruak River, their main stream, the Khong River, and small branch streams of these rivers. In Chiangmai, Lam Pang Provinces, the Ping River and Doi Tao area of Bhumipol Dam Reservoir, the Wang River and Kiu Lom Dam Reservoir, and their branch streams were densely infested with Mimosa pigra plants (Figure II-1).

On habitats of this species, plants were mainly growing at marginal areas along banks of canals, rivers and lakes, but they also inhabited water-logged areas as seen in Kiu Lom Dam and Doi Tao area of Bhumipol Dam Reservoirs (Plate I-6). Concerning on this habitat, by our greenhouse experiments as mentioned in another chapter, it was certain that they had germinated from soils in upland condition, when water level was low in dry season. As an example, water level of Kiu Lom Dam Reservoir fluctuated about seven meters during one year in 1980, by the data of dam control office there (Table II-1). After germinating, young plants of Mimosa pigra might be able to grow up in flooded condition, as water level rose up month by month.

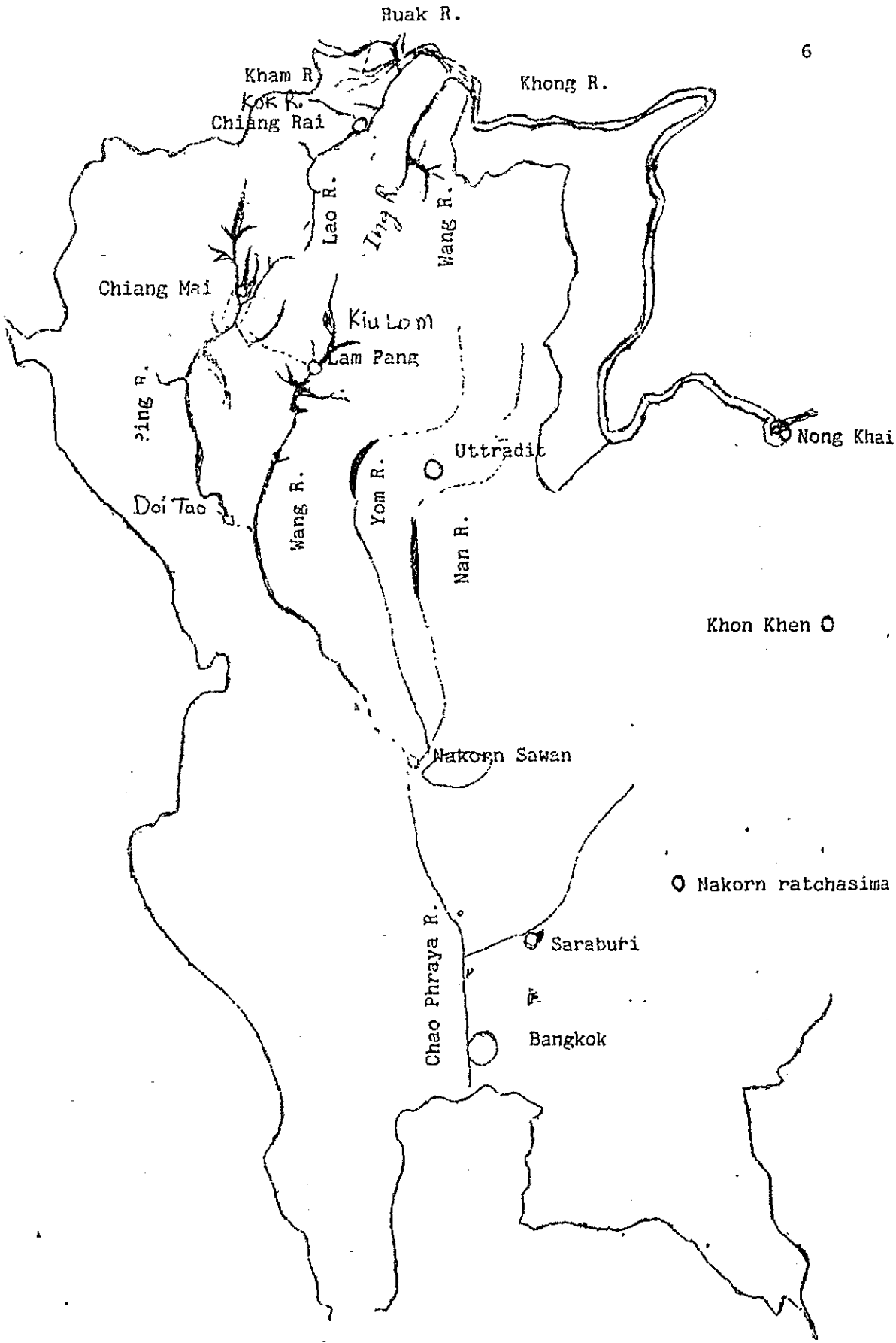



Figure II-1 Distribution of Mimosa pigra L. by this survey.

Table II-1. Change of water level in Kiu Lom Dam Reservoir [1)]

| Month | Height of water surface from sea level (ca. average) | Rate of water flow from dam |
|---|---|---|
| 1980, Jan. | 284 m | 2-6 $m^3$/sec |
| Feb. | 282 | 4-6 |
| Mar. | 280 | 1-5 |
| Apr. | 279 | 1-3 |
| May. | 278 | 1-4 |
| Jun. | 280 | 2-4 |
| Jul. | 279 | 5-7 |
| Aug. | 283 | 6-7 |
| Sep. | 283 | 7-175 |
| Oct. | 285 | 2-20 |
| Nov. | 284 | 4-8 |
| Dec. | 284 | 4-25 |

1) Data from Kiu Lom Dam Control Office

Mimosa pigra infested lots of abandoned paddy fields and roadsides, especially around Chiangmai city (Plate 7). The area of these habitats are not so much in other provinces, but it shows the adaptability of this species to upland field conditions.

About the abandoned paddy fields, they were mainly owned by absentee landlord who did not care about the weed management (1)(16). These lands were once covered with overflown water from Mimosa infested the Ping River several years ago, when there was a big flood around the city. For the road construction, much of the river basin sand or soil of Mimosa infested area were widely used and Mimosa seeds were propagated along these new roads. Wheel of cars running over roads also spread Mimosa seeds elsewhere along roads. Therefore, major parts of the Mimosa vegetations should be considered to be aquatic or aquatic-organated (1). But their vegetations under upland condition as in road-sides seemed not to be vigirous, because authors could not find any big Mimosa vegetation in upland fields or in mountain woods along these roads, except wetted places like ponds or streams in valleys. Mimosa plants seemed to have no ability to invade and establish big vegetation in mountain.

In farming areas, usually we found they were growing thickly only along the aquatic places like streams, rivers or lakes. They did not make stand even in the wetted paddy fields around there (Plate 6).

So, if farmers are cultivating and weeding their lands carefully, Mimosa pigra plants can not invade agricultural areas (Plate 8). In aquatic areas, it was interesting that Mimosa pigra could not infest deep water areas in rivers (Plate 5), lakes or reservoirs. In these areas,

they were found only shallow water river basin along banks and, in reservoirs, usually, they were infesting only upstream areas. Near dam areas, we could find only a few plants. These observations and other experimental results show that they could not germinate from deep water areas which were water-logged, permanently. They could germinate only in soils, under upland condition in dry season as mentioned above. Sometimes, even the established Mimosa pigra vegetations were killed by deeply flooded water as we found at Doi Tao area of Bhumipol Dam Reservoir (Plate 2,9).

Computer-analyzed colour picture of "Landsat" datum on Kiu Lom Dam Reservoir area showed the usefulness of this method to survey the change of Mimosa pigra vegetations by Satellite in future (Plate 10).

This survey and greenhouse experiments suggest that Mimosa pigra L. have the potentiality to infest many other water systems of Thailand in future.

Some people recently reported the distribution of this species in Nong Khai Province, Southern province close to Malaysia and others (12) (16) (21). However, this species can not grow at aquatic areas where the bottom soil is covered or flooded with water whole year. Therefore, it will be certain that Mimosa pigra plants can not infest downstreams of the Chao Phraya River up to Bangkok or the Khong River up to Vietnam because the bottom soil of rivers will be kept covered by water whole year.

# III. EFFECTS OF SOIL CONDITIONS AND WATER LEVELS ON SEED GERMINATION AND ESTABLISHMENT OF MIMOSA PIGRA L.

Hidejiro CHIBA and Cha-um PREMASTHIRA

## 1. Introduction

In natural conditions, Mimosa pigra L. plants are infesting mainly roadsides, abandoned fields and aquatic areas as irrigation canals, rivers and dam reservoirs. About roadsides and upland fields, they grew mainly on newly constructed roads and in fields around them. Along aquatic areas, they were often observed to grow and establish their stands even at water-logged places, especially, in rainy season. Therefore, for investigating Mimosa pigra infestation or control, it is necessary to find, in what conditions Mimosa seeds can germinate and establish their stands[4](26). The purpose of experiments in this Chapter was to study the germination and establishment of Mimosa pigra in several kinds of soil, different sowing depths in soil and different levels of water to cover seeds and seedlings.

## 2. Materials and methods

In all experiments, Mimosa pigra seeds, which were collected at the natural habitat in Nakorn Nayok Province in August, 1981 and stored in air-dry condition at room temperature, were used after breaking dormancy by soaking in boiling hot water for 5 min. They were sown mainly in soils of black soft plastic pots (diameter 11 cm and height 10 cm) for germination tests.

Soil experiments :

Soil samples were collected from 7 places of Central, Northeastern and Northern regions of Thailand (Table III-1), and filled in pots under upland condition. Twenty seeds were sown in each pot.

Table III-1. Effects of soils [1] collected from different places on seed germination of Mimosa pigra L.

| Soil type | Germination rate 1 week | 2 weeks | 3 weeks [2] |
|---|---|---|---|
| Test from Sept. 18th, 1981 | | | |
| Sand | 85% | 85% | 85% |
| Upland soil, sandy [3] | 3 | 61 | 61 |
| Upland soil, black [4] | 78 | 78 | 78 |
| Upland soil, red [5] | 84 | 84 | 84 |
| Mountain soil, Marl [6] | 79 | 82 | 82 |
| Paddy soil (B), dried [7] | 34 | 49 | 57 |
| Paddy soil (B), wet [7] | 64 | 68 | 69 |
| Test from June 21st, 1982 | | | |
| Sand | 75 | 75 | 75 |
| Paddy soil (C), dried [8] | 80 | 83 | 83 |
| Wasteland soil, dried [9] | 63 | 73 | 78 |

1) in upland condition

2) No germination after 3 weeks

3) From Pakchong, Nakorn Ratchasima

4) From Pattananikom, Lopburi

5) From Muang, Mahasarakam

6) From Tara, Saraburi

7) From Bangkhen, Bangkok

8) From Chiangmai

9) From Doi-Tao, Chiangmai

Five soils were tested on September 18th, 1981, with 5 replications, and two others were tested on June 21st, 1982, with 2 replications. The number of germinated and established seedlings were counted every week around one month.

Effect of sowing depth on seed germination and emergence was studied four times in 1981 and 1982, with big plastic pots (diameter 15 cm and height 20 cm, or diameter 20 cm and height 30 cm) and wooden root boxes (size: 30x20x5 cm) with glass plate on one side. They were filled with sandy soil or sand. Seeds were sown on August 18th and September 29th, 1981, into soil depth of 1, 3, 5, 7, 10, 15 and 20 cm by pot experiments, or on July 27th and September 20th, 1982, into soil depth of 5, 6, 7, 8, 9, 10 and 12 cm by root box experiments. Pot experiments were 5 replications with 20 seeds per pot, but root box ones were 2 replications with 10 seeds for each depth. After one month, number of emerged seedlings were counted.

Water level experiments :

Effects of water levels on seed germination and establishment of Mimosa pigra L. were tested three times in 1981 and 1982. Seeds were sown on sand or sandy soil of black plastic pots after breaking dormancy by soaking them into boiling water 5 min, and covered by sand about 2 or 3 mm. These pots were submerged into water at the depth of -5, -3 (under the soil surface, respectively), 0, 1, 3, 5, and 10 cm. Sowing dates were August 19th, October 8th and December 28th of 1981, and the growth of germinated plants was observed during one month and a half (1st experiment) or 4 weeks (2nd and 3rd experiments).

Effects of changes of water levels on the establishment of Mimosa pigra seedlings were studied in 1981. Seeds were sown in black plastic pots on August 25th in upland condition. As seedlings grew up, they were flooded by tap water to get water levels under cotyledon to cover soil surface and their root systems, under 1st leaf, under 2nd leaf, under 3rd leaf, and above all leaves of treated plants (Figure III-1), until the end of experiment except above all leaves were measured on December 4th.

Figure III-1. Levels of water-flooding in pots for seedlings of Mimosa pigra L.

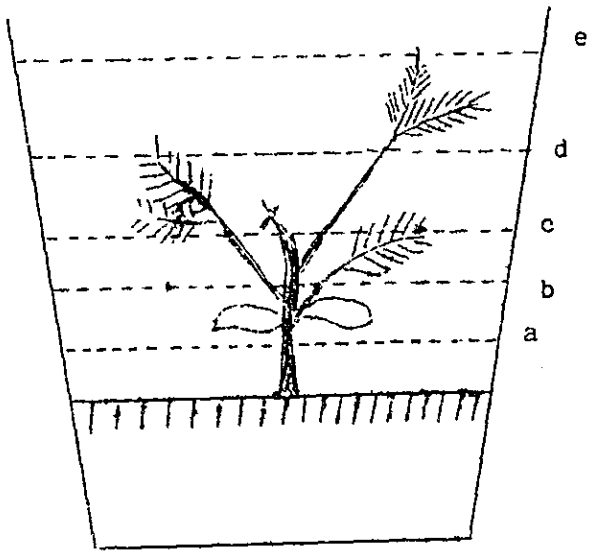
a : under cotyledon

b : under 1st leaf

c : under 2nd leaf

d : under 3rd leaf

e : all leaves (complete flooding)



3. Results and discussion

Soil Experiments :

Mimosa pigra seeds had germinated well from all kinds of tested upland and paddy soils as in Table III-1., although in some soils, their germination rates were a little bit lower than others.

About the sowing depth experiments, authors found that hard seeds of Mimosa pigra could swell by imbibing water and germinate even from 20 cm depth of soil under upland condition, but they could emerge up to the soil surface only from soil within 7 cm depth (Table III-2). When seeds were placed deeper than 7 cm in soil, they could germinate and grow in the soil, but their cotyledons could not reach the soil surface because elongation of hypocotyl stopped below the surface as in Plate II. All of these underground seedlings had decayed to die later. On the other hand, by the unreported observation, in water flooded condition, scarified seeds by boiling hot water could also swell by imbibing water when they were buried under soil surface of the bottom, but they could not germinate at all, probably because of dormancy induced again in the anaerobic soil condition. These swollen seeds were black colour, and had germinated when they were digged out of flooded bottom soil and put in the aerobic condition.

These results are almost similar to Phanthumnavin's (2), and show that Mimosa pigra L. can grow probably on any kinds of soil at any areas, but, that, about the depth of soil, it can not emerge unto the soil surface if seeds will be buried in deeper soil than 7 cm by cultivation or other practices.

Water level experiments :

When water was flooded at depth of 0 to 20 cm over soil surface after Mimosa pigra seeds were sown, seeds had imbibed water, swollen and germinated to elongate radicles and cotyledons a little bit. These cotyledons were green colour under flooded water and seemed to be normal. However, germinated seedlings could not establish on the bottom soil under flooded water, because their radicles could not grow into the soil, and curved upwards or wound in the water without attaching or holding the soil. These seedlings were detached from swollen seed coats, and usually floated up to the water surface and finally decayed to die later. In our observations, Mimosa pigra plants which germinated under flooded water could not establish on the soil, even when they were attached to marginal soil surface above water level, after floating up. Only a few seedlings were alive in 0 cm flooded soil in this experiment, but their growth was very limited. Results of three tests were almost same, so, only the result of the first one was shown in Figure III-2.

Effects of water-flooding on growth and establishment of Mimosa pigra seedlings were shown in Table III-3.

Complete flooding (all leaves, in Table III-3) over Mimosa pigra seedling during 2 weeks (flooded at cotyledon stage), 3 weeks (flooded at 1st leaf stage), 4 weeks (flooded at 2nd leaf stage), and 5 weeks (flooded at 3rd leaf stage) killed all plants in treated pots, but 2 weeks flooding at 2nd leaf stage or 1 and 3 weeks flooding at 3rd leaf stage did not kill any seedlings, and their regrowth began quickly when they were back to the upland condition. On the other hand, 3 months flooding were found to kill even the big vegetation of Mimosa pigra in Doi Tao area of Phumipol Dam Reservoir in 1981 (Plate 2,9). In our experiment, we used tap water as

Table III-2. Effect of sowing depth [1] on seed germination of Mimosa pigra L.

| | Sowing depth | Germination rate | |
|---|---|---|---|
| | | 1 week | 2 weeks [2] |
| | 1 cm | 71% | 75% |
| Sandy | 3 | 40 | 44 |
| Upland | 5 | 43 | 45 |
| Soil | 7 | 34 | 36 |
| | 10 | - | - |
| | 15 | - | - |
| | 20 | - | - |
| | 1 cm | 86 | 87 |
| | 3 | 82 | 84 |
| Sand | 5 | 67 | 69 |
| | 7 | 32 | 48 |
| | 10 | - | - |
| | 15 | - | - |
| | 20 | - | - |

1) In upalnd condition

2) Nc germination after 2 weeks

flooding water which was clearer than natural river or canal water, because natural one contained much soil particles and subsiquently reduced the light intensity in water. Therefore, it was probable that completely submerged plants in this experiment could survive more days than plants flooded by river water in natural condition.

Soil surface flooding under cotyledon or flooding under other leaves did not kill Mimosa seedlings, although their root development was inhibited much in these seedlings as shown in smaller top-root ratio than 4.7 of the untreated control plants (Table III-3).

By water level experiments, it would be concluded that Mimosa pigra L. seeds could germinate even in water-flooded condition when their dormancy was broken, but that they could not grow and establish in that condition, because germinated seedlings would float up to the water surface without standing on the bottom soil and would be decayed to die later. Mimosa pigra seedlings, which germinated on the soil where water level was lower than soil surface, could grow and establish their stands on the soil. Furthermore, after establishing in upland condition, they were very tolerant to water-flooding if some upper leaves would be above water surface. Even by complete flooding in the rainy season, it would take a few weeks to kill the submerged Mimosa pigra seedlings.

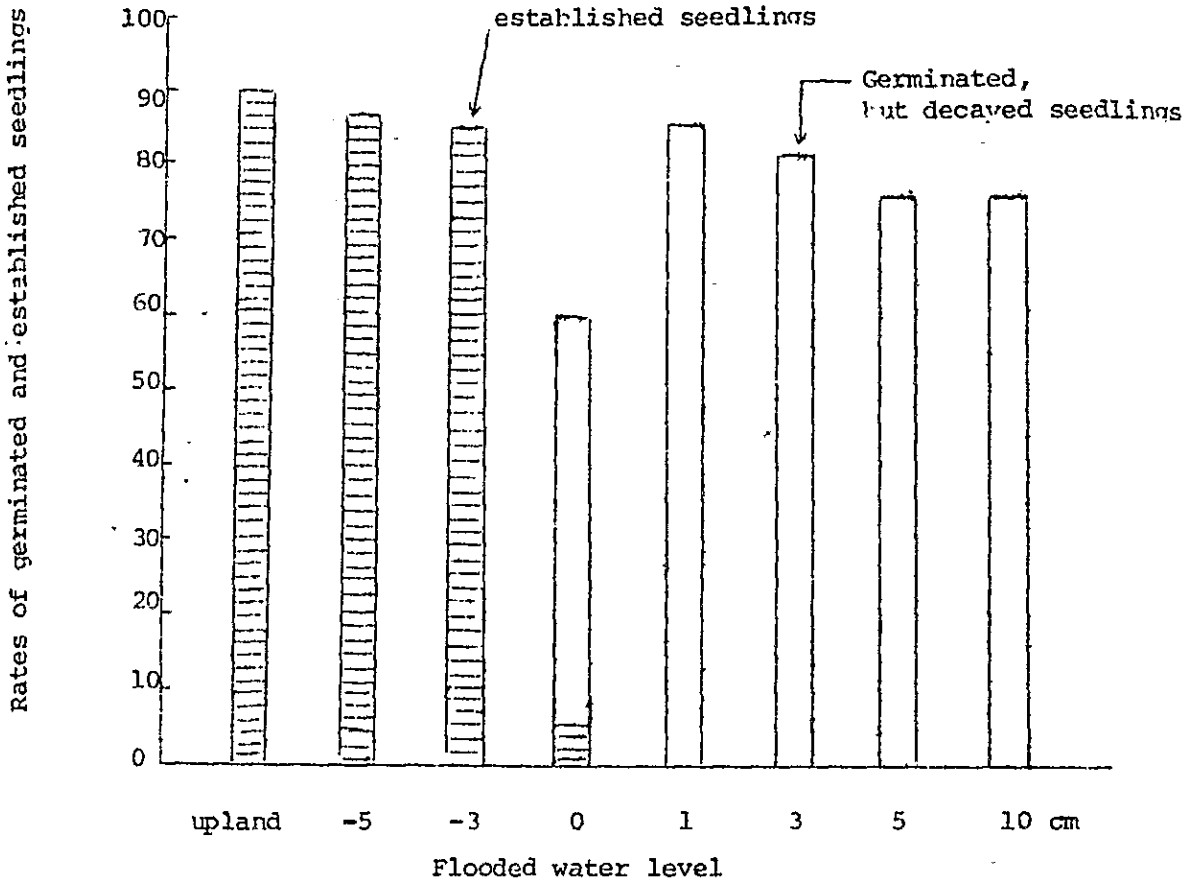



Figure III-2 Effects of water levels on seed germination of Mimosa pigra L. (4 weeks after sowing)

*) Level of -5 or -3 cm shows that the water level was 5 or 3 cm below the soil surface.

**) In the flooded condition (water level 0-10 cm), some seeds could germinate, but decayed (0 cm) or floated up on the water surface and decayed (1-10 cm).

Table III-3. Effects of water-flooding on growth of seedlings of *Mimosa pigra* L.

| Leaf stage of *Mimosa* at flooding | Depth of flooding | Number of survived plants | Fresh weight per plant | Top-root ratio (T = 1) |
|---|---|---|---|---|
| Cotyledon | All leaves (2 weeks) | 0 % | 0 % | 0 |
| | Under Cotyledon | 85 | 76 | 3.6 |
| | All leaves (3 weeks) | 0 | 0 | 0 |
| 1st leaf | Under 1st leaf | 31 | 60 | 2.6 |
| | Under Cotyledon | 98 | 39 | 3.0 |
| | All leaves (4 weeks) | 0 | 0 | 0 |
| | All leaves (2 weeks) | 86 | 66 | 3.5 |
| 2nd leaf | Under 2nd leaf | 88 | 42 | 2.2 |
| | Under 1st leaf | 92 | 57 | 2.9 |
| | Under Cotyledon | 89 | 48 | 3.8 |
| | All leaves (5 weeks) | 0 | 0 | 0 |
| | All leaves (3 weeks) | 46 | 20 | 1.9 |
| | All leaves (1 week) | 95 | 107 | 3.9 |
| 3rd leaf | Under 3rd leaf | 80 | 29 | 1.7 |
| | Under 2nd leaf | 86 | 75 | 3.1 |
| | Under 1st leaf | 96 | 67 | 4.0 |
| Untreated Control | | 100 | 100 | 4.7 |

# IV. EFFECTS OF TEMPERATURE AND OTHER FACTORS ON SEED GERMINATION OF MIMOSA PIGRA L.

Hidejiro SHIBAYAMA and Walapa PORNSUKSAWANG

## 1. Introduction

Control of Mimosa pigra L. vegetations by herbicides has been successfully tried by many government officials and private sectors (3) (8) (10) (15) (17) (19) (21). However, seed germination and establishment of this species will be also problem when we consider infestations of Mimosa pigra to new habitats or its re-infestations after removal of the cover by chemical or mechanical methods (14). This work was conducted to investigate some biological characters of seed germination of Mimosa pigra L.

## 2. Materials and methods

Temperature experiments :

This experiment was conducted by incubator and hot water bath in August to October, 1982. Petri dishes with moistened filter paper were used for incubator experiment, and after 1 or 2 weeks' treatment under constant temperatures of 0, 5, 10, 15, 20, 25, 30 and 35°C, or under alternating day - night temperatures of 20-10, 25-5, 25-10, 30-15, 30-20, 35-20 and 35-20°C, dishes were kept in room temperature condition during 2 weeks. These alternating temperatures were chosen by the data of Meteorological Department on North and Central regions of Thailand (9). Daytime was from 6.00 a.m. to 6.00 p.m., and night time was from 6.00 p.m. to 6.00 a.m..

Main seeds tested in this experiment were 'old seeds' which were collected in August, 1981, at the natural vegetation in Nakorn Nayok Province, and were kept in dry or wet condition at room temperature for one year or more. Another ones were 'new seeds' which were collected in August, 1982, at the same place, and were kept in the same condition for a few months.

In hot water bath experiment, test tubes were used for temperature treatment during 1 sec to 1 week, under constant temperatures of 30, 50, 65, 75, 85, 90, 95 and 98°C, the last of which was the highest temperature obtained by boiling water. Then, treated seeds were moved to petri dishes with filter paper and were kept in room temperature condition during 2 weeks. All seeds tested in this experiment were 'new seeds' mentioned above.

Other experiments :

The effect of light in day time (dark in night time) or dark in whole day on Mimosa seed germination was tested by petri dishes in incubator, under alternating day-night temperatures of 30-15 and 30-20°C, in September to October, 1982. Periods of day and night times were same as before, and, after 1 week treatment, dishes were moved to room temperature condition. 'Old and new seeds' stored in dry and wet conditions were sown to dishes (20 seeds per each) with 5 replications.

Mimosa seeds collected from natural vegetations in Chiangmai and Nakorn Nayok Provinces were tested to compare germination rates after breaking dormancy by boiling hot water 5 min, in September of 1982.

Twenty seeds were sown to each petri dish with 5 replications.

Burning by flame and scrubbing by sand paper were treated to Mimosa 'new seeds', because it was often said that Mimosa seeds germinated in large numbers, after burning their vegetations along roadsides, or after using river sand for road construction in which Mimosa seeds were numerously mixed. After treatments, seeds were put in petri dishes (20 seeds per each) and were kept at room temperature.

As methods to break dormancy of Mimosa 'new seeds', conc. $H_2SO_4$ and HCl for 0.5 to 10 min, and organic chemicals such as acetone (99.5 and 98%), ethyl alcohol (100, 99.8 and 70%), ethyl ether (99 and 95%), benzene (100%), xylene (96%), toluene (97.5%) and chloroform (99%) for 10 min, 1 hr and 1 day, were treated in November and Decemebr of 1982, and February of 1983. After treatments, seeds were washed by running tap water and were kept in petri dishes ( 20 seeds per each) with 5 replications at room temperature.

## 3. Results and discussion

Temperature experiments :

In constant temperature experiment, hot water was effective for breaking dormancy of Mimosa seeds by 1 sec to 1 week treatment and the germination rate was the higher as temperature was the higher up to 98°C (Figure IV-1, IV-2). In each temperature, the germination rate increased, reached to the maximum and decreased again, as treatment time became the longer (Figure IV-1)(26).

Low temperatures as 5 and 10°C of incubator experiment were also very effective for breaking dormancy of 'old seeds' by 1 week treatment, but, as temperature was the higher, the germination rate was the lower (Figure IV-2).

In alternating temperature experiment, 10 to 20°C differences of day and night temperatures treated during 1 or 2 weeks strikingly induced the awakening of seeds from dormancy (Figure IV-3). Especially, at day temperature 30 or 35°C, 15°C difference was necessary to get the higher germination rate, but at day temperature 25°C 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 1982 (Figure IV-3).

Other experiments :

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

Sites of seed collection might have some difference in Mimosa seed germination, because when hot water was treated for breaking dormancy, seeds from Chiangmai germinated more than those from Nakorn Nayok (Figure IV-5).

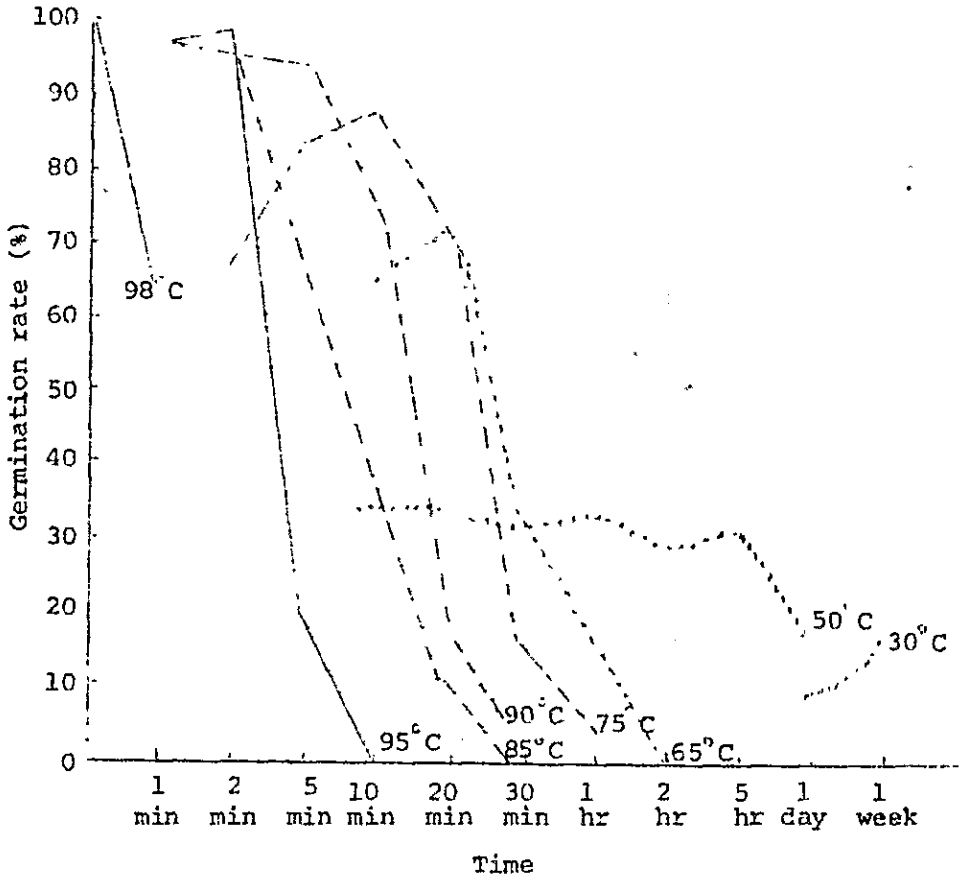



Figure IV-1. Effect of periods of constant temperature treatment by hot water bath on germination of 'old seeds (1981)' of Mimosa pigra L.

Experiment was conducted in August to October, 1982.

Seeds were moved to room temperature after treatment.

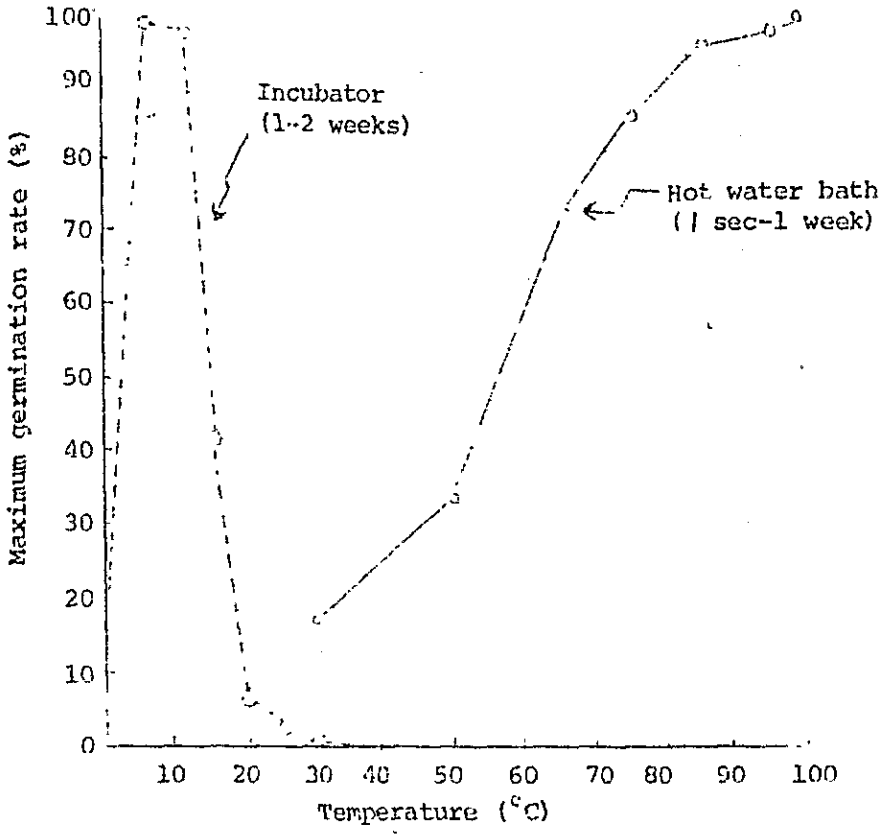



Figure IV-2. Effect of constant temperatures on maximum germination rate of 'old seeds (1981)' of Mimosa pigra L.

Experiment was conducted in August to October, 1982. Seeds were moved to room temperature after treatment.

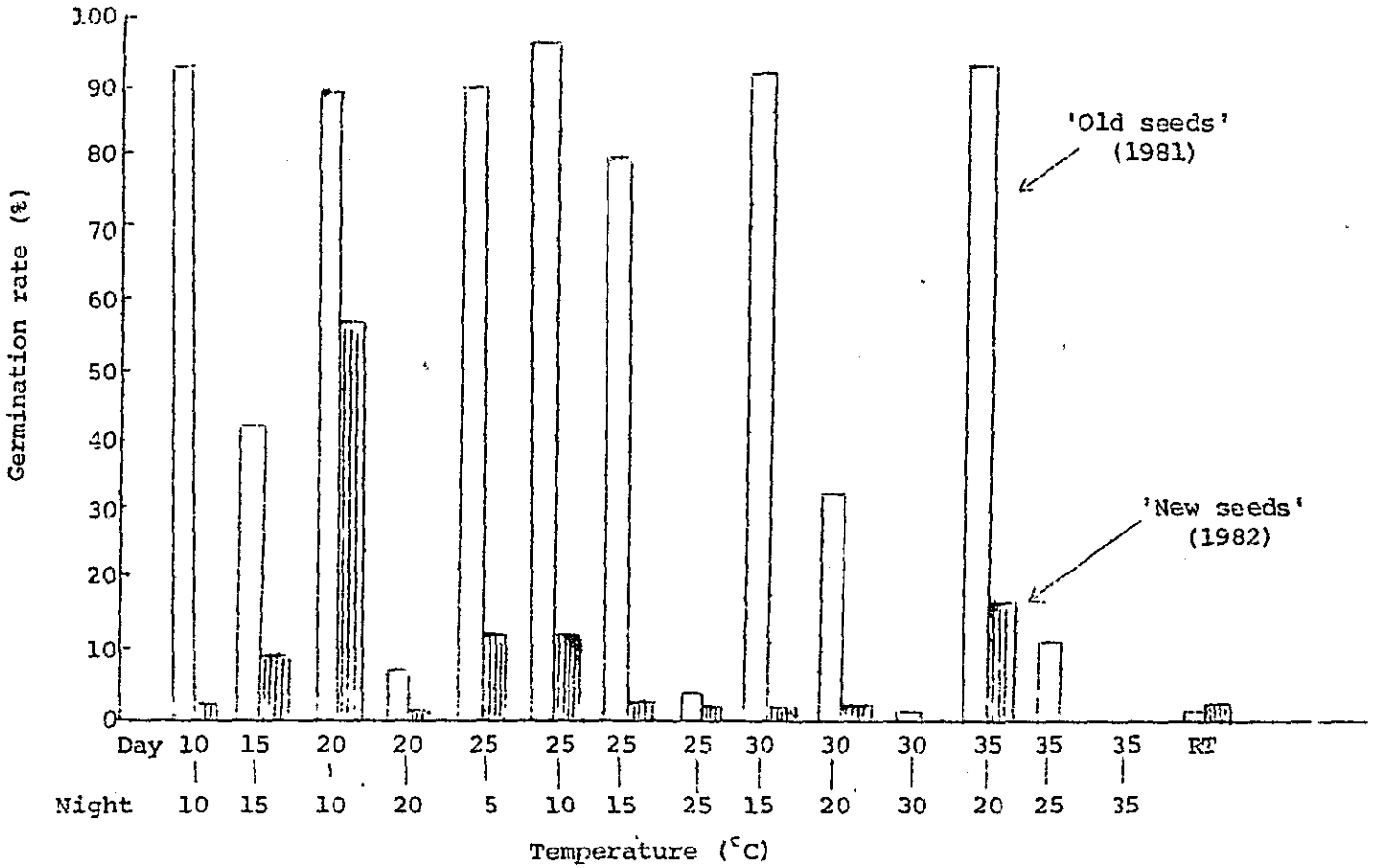



Figure IV-3. Effect of alternating temperatures on germination of 'old (1981) and new (1982) seeds'. Experiment was conducted in August to October, 1982. Temperatures were treated one or two (day temperature 25°C only) weeks, and then, seeds were moved to room temperature.
Day : 6.00 a.m. - 6.00 p.m.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

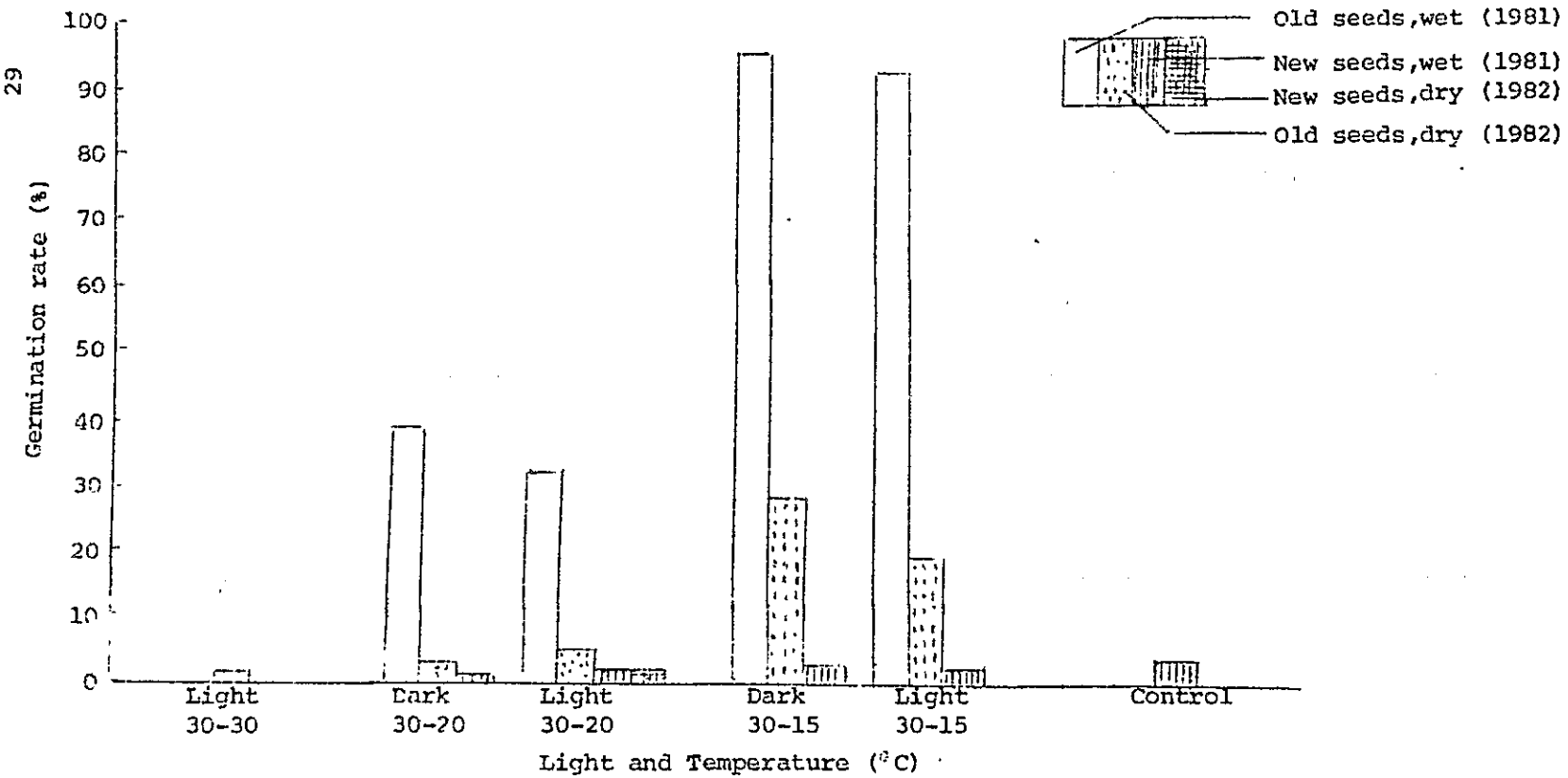



Figure IV-4. Effect of light and storage conditions on seed germination of Mimosa pigra L.

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

Experiment was conducted 30-20 or 30-15°C temperature at alternating on September to October, 1982

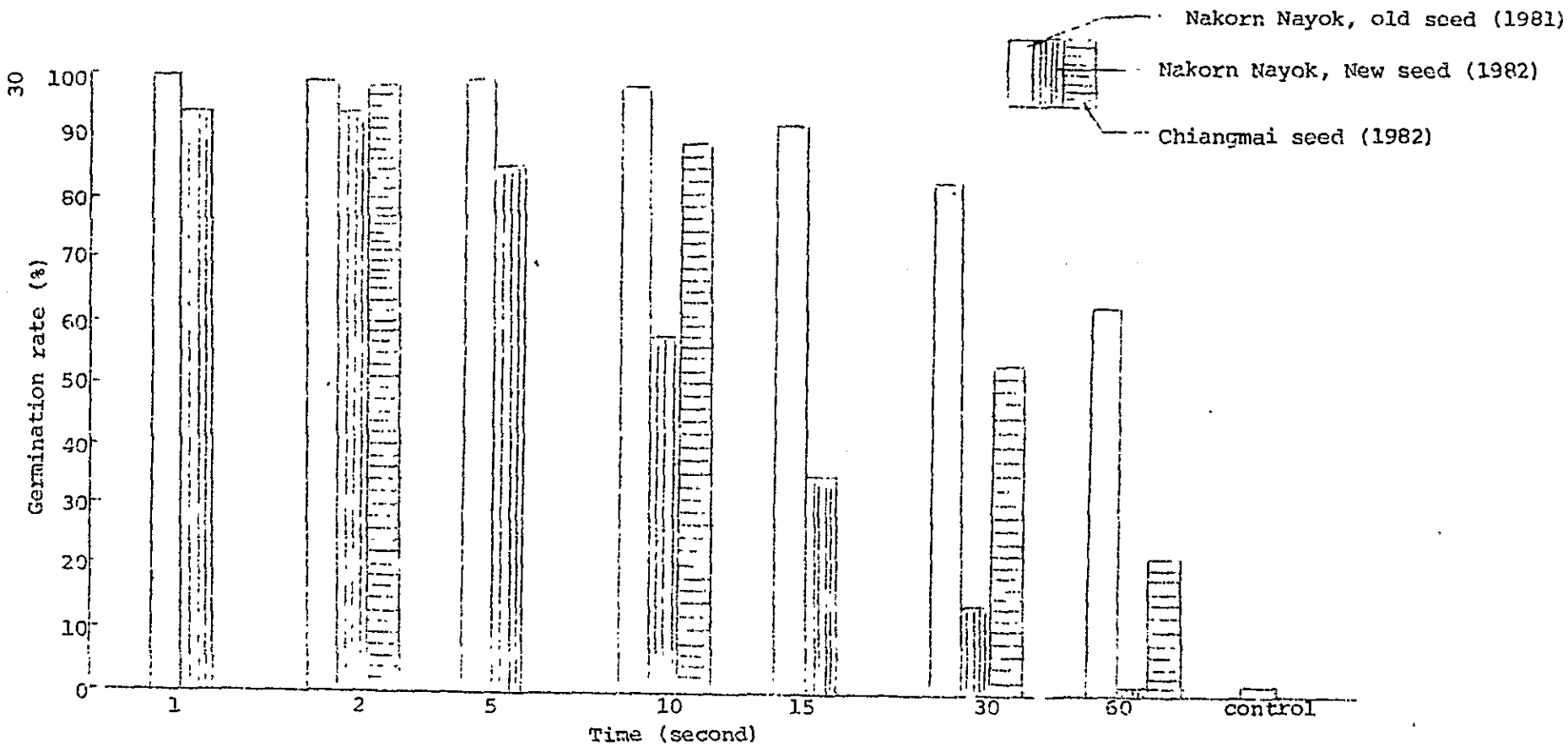



Figure IV-5. Effect of boiling hot water (98 °C) on germination of Nakorn Nayok and Chiangmai seeds. Experiment was conducted in September, 1982.

Burning by flame was effective for breaking dormancy of Mimosa 'new seeds'(Figure IV-6), but usually flaming more than 10 or 20 seconds was too much and burned seeds were almost popped away. These seeds did not germinate at all. Scrubbing seeds by sand paper was also effective for germination (Figure IV-6),but, when seeds were mixed into small sand bag and scrubbed strongly by hand or beated on the ground several times, their germination was not enhanced at all in our experiment.

Conc. $H_2SO_4$ treated to dormant Mimosa 'new seeds' during 0.5 to 10 min was very effective for germination, but conc. HCl did not have any effect for breaking seed dormancy (Figure IV-6).

Among organic chemicals, only 99.8% acetone (analytical grade) was effective for the awakening of dormant Mimosa seeds, but others including even 98% acetone (extra pure grade), did not show any effectivity for seed germination (Figure IV-7).

In natural condition, seeds of Mimosa pigra L. seem to germinate the more as they become the older. In our experiments, 'old seeds' which were stored more than one year after collecting showed the better germination rate than 'new seeds'. Moreover, Bhanthumnavin (2) got the better germination rate than ours when she used four or five years' stored Mimosa seeds for experiments, and reported that 64% of seeds had germinated at room temperature (32°C) during 10 days. These results suggest that the germination rate of Mimosa pigra seeds will rise up year by year after ripening and dropping down on the soil surface or the bottom of water in aquatic areas.

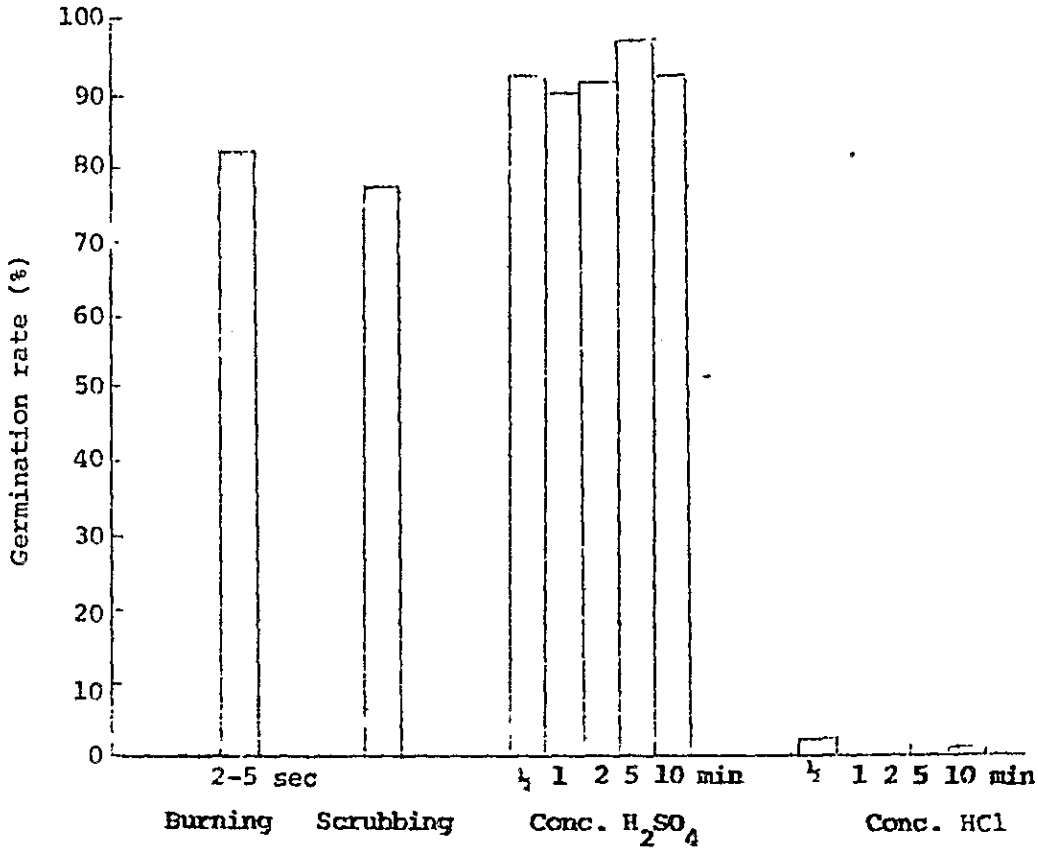



Figure IV-6. Effects of burning by flame, scrubbing by sand paper, conc. $H_2SO_4$ and conc. HCl on germination of 'new seeds' of Mimosa pigra L.

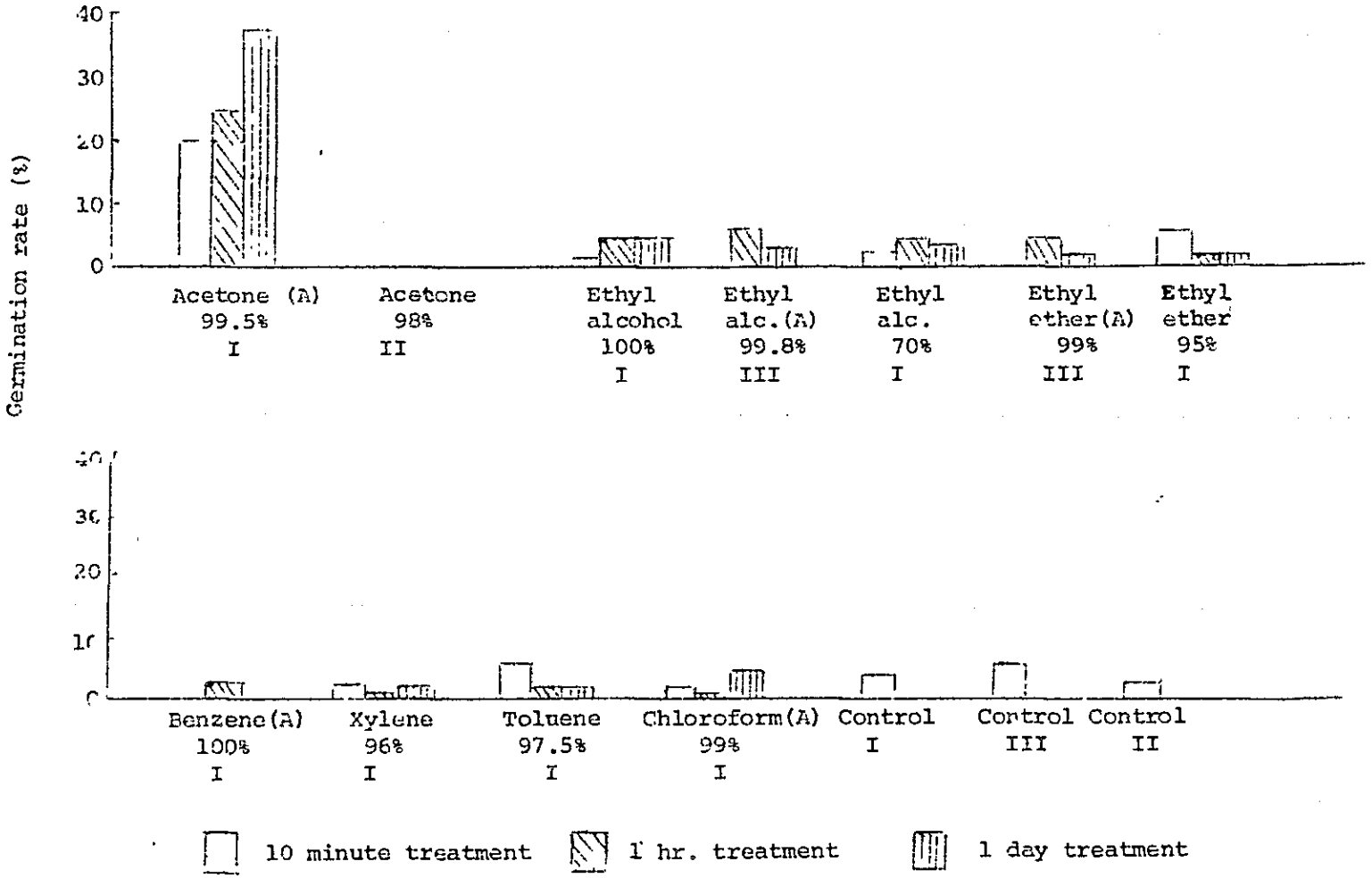



Figure IV-7. Effect of organic chemicals on seed germination of Mimosa pigra L. Experiments were conducted three times in November (I), December (II) of 1982 and February (III) of 1983. (A) : Analytical grade, Others were extra pure grade. New seeds (1982) were used.

Seed germination of Mimosa pigra L. was enhanced strikingly in this study when low temperatures such as 5 to 20°C were treated in constant or alternating temperature experiment. By the data of Meteorological Department (9), mean maximum and minimum temperatures of winter season in Chiangmai were around 29 and 15°C (Figure IV-8). So, one of the reason of Mimosa's excessive invasion in Northern Thailand will be the low temperature in the region.

Firing Mimosa pigra plants along roadsides, or moving sand or soil mixed with Mimosa seeds for road construction were also almost confirmed experimentally to induce the awakening of Mimosa seeds from dormancy, although sand mixing did not have any effect for seed germination in this experiment.

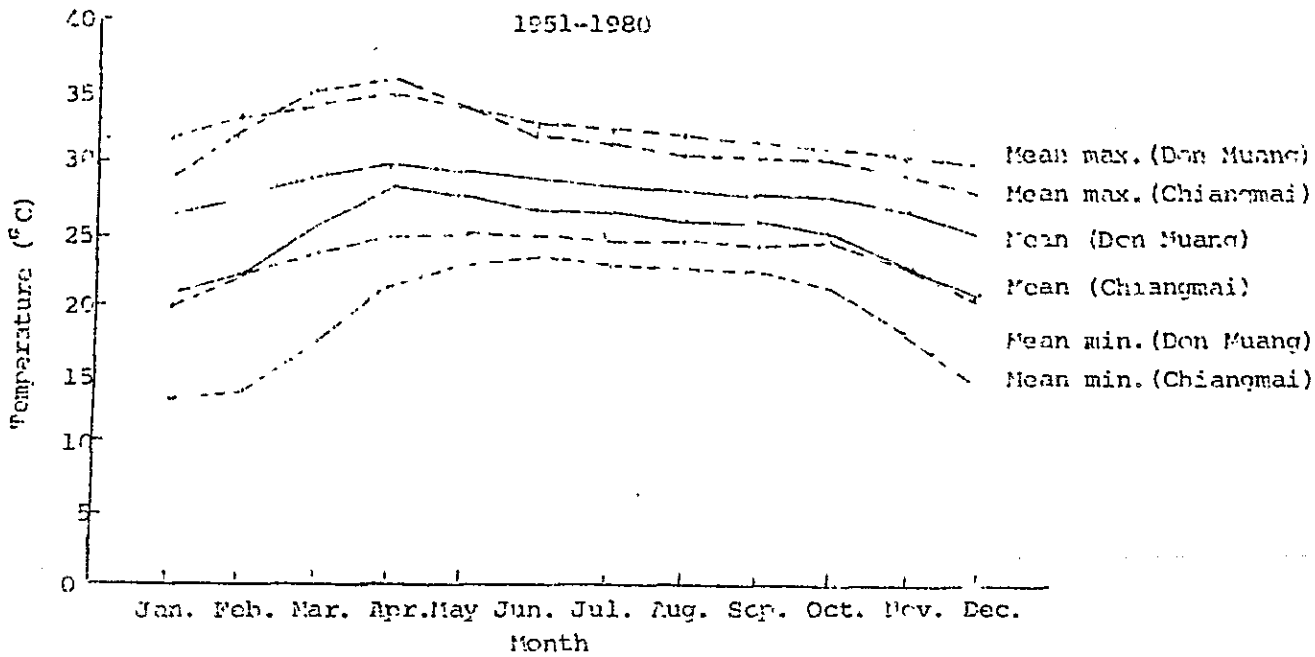



Figure IV-8. Mean temperatures for the 30 year period of 1951-1980 in Chiangmai and Bangkok (Don Muang). (Data from Meteorological Department)

# V. SCANNING ELECTRON MICROSCOPIC OBSERVATIONS ON SEED COAT OF MIMOSA PIGRA L.

Hidejiro SHIBAYAMA and Walapa PORNSUKSAWANG

## 1. Introduction

When environmental or artificial factors affected the seed germination of Mimosa pigra L., it was considered that the seed coat dormancy was broken by these factors (2). On the other hand, change of water permeability of strophiole or hilum area of the seed (Figure V-1) was found to be important for the imbibition and dormancy breaking of some leguminous seeds, and most parts of seed coat were found not to be the primary site of water entry (4).

This work was conducted to investigate what part of Mimosa pigra seed would be affected by dormancy breaking factors and would result in the increase of seed coat permeability through its change.

## 2. Materials and methods

After various treatments for breaking dormancy mentioned in previous Chapters, vaselline was coated over the seed coat of Mimosa pigra L. at the top end, middle and base end of each seed (Figure V-1). For each site of vaselline coating after various treatments, 20 seeds were used in one petri dish with 3 or 5 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 Mimosa pigra L. was observed by the Scanning electron

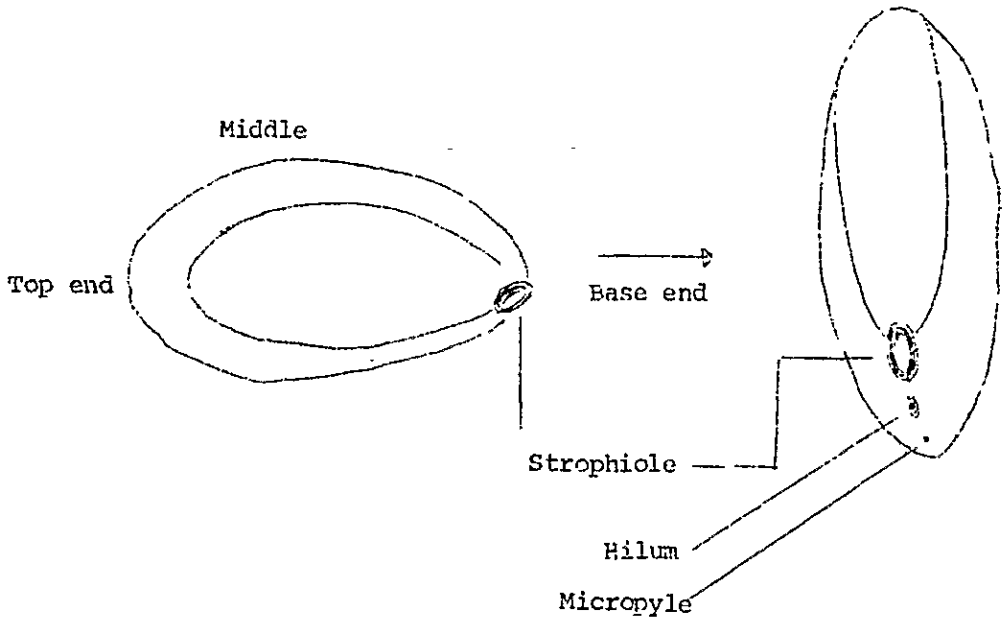



Figure V-1. The top end, middle and base end of Mimosa pigra L. seed (left), and tissues at the base end (right).

microscope, AKASHI MINI SEM Alpha-9, after gold coating by Ion Coater IB-3 for 3 min. The purpose of this observation was to investigate the change of seed coat, especially, at the base end (Figure V-1), after various treatments for breaking dormancy.

3. Results and discussion

Vaselline coating experiment :

After six kinds of treatments as in previous Chapters, the seed coat of Mimosa hard seed was affected, and many of them began to imbibe, swell and germinate as mentioned. However, when vaselline was coated over the top end, middle and base end of each seed (Figure V-1) after treatments, these coated seeds revealed different abilities to absorb water and germinate.

As in Figure V-2, seeds treated by boiling hot water, alternating temperature, flame burning and acetone germinated a little or none, when their base ends were coated with vaselline, but those, of which middles 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 same as uncoated seeds, even when their base ends were coated with vaselline.

As it has been wellknown, there are strophiole, hilum and micropyle tissues at the base end of seeds of some leguminous species, as same as Mimosa pigra L. So, treatments of boiling hot water, alternating temperature, flame burning and acetone, which had induced the water imbibition through base ends, would be effective mainly to change the water permeability

of these tissues (4). However, those treatments seemed to be ineffective for enhancing the imbibition through other parts of seed coat. On the other hand, conc. $H_2SO_4$ and sand scrubbing treatments seemed to cause the change of the water permeability at any part of seed coat.

Scanning electron microscopic observations :

By boiling and low temperature treatments, there was little change at the top end and middle part of Mimosa seed comparing to untreated one (Plate 12). However, strophioles at base ends were frequently swollen and cracked after these treatments, which seemed to become sites of water entry to break dormancy (Plate 13,14,15) 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 (Plate 16), 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.

So, in natural condition, it seems that the dormancy of Mimosa pigra seeds will be broken mainly by factors which will induce swelling and cracks of strophiole, although Egley (3) and others reported that hilum was also the main site of water permeability for some other leguminous species.

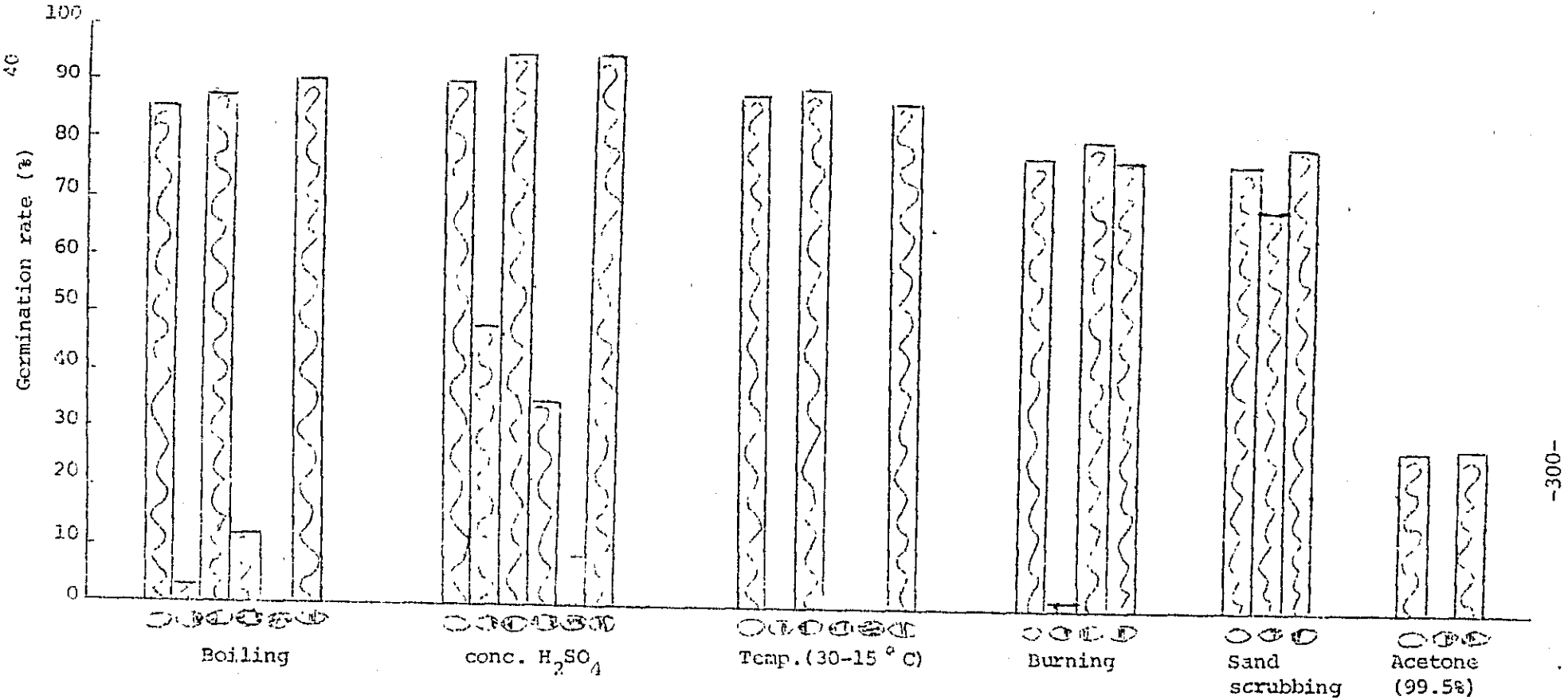



Figure V-2. Effect of vaselline coating on seed germination. New seeds (collected in 1982) were used for these treatments except alternating temperature in which old seeds (collected in 1981) were used. Vaselline was coated at black portions. Left part of seed was the top end, and right one was the base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

# VI. EFFECTS OF HERBICIDES AND GROWTH REGULATORS ON SEED GERMINATION AND EMERGENCE OF MIMOSA PIGRA L.

Cha-um PREMASTHIPA and Hidejiro SHIBAYAMA

## 1. Introduction

Atempts to control Mimosa pigra L. in the past were by using post-emergence herbicides (3) (8) (10) (15) (19) (20) (21) and biological means (6) (7) (12), and, although the latter one will be rather important under the long-term control program, the former means is the most successfull at present. This paper reports on effects of certain pre-emergence and post-emergence herbicides and growth regulators at different concentrations on germination of Mimosa seeds and their subsequent development. Post-emergence herbicides were included in this study because after applying them to Mimosa vegetations, they were considered to have some effects on seed germination(5)(13)(14).

## 2. Materials and methods

Pre-emergence herbicide applications in pots and petri dishes :

Pots were filled with upland soil and kept in upland condition. Nitrofen, oxadiazon, benthiocarb, amiben, alachlor, butachlor and diuron were treated as pre-emergence at 0.5 and 1.0 kg(ai)/rai on January 26, 1982, just after sowing Mimosa seeds which had been soaked in boiling hot water for 5 min to break dormancy (14). Twenty seeds were sown in each dish with 5 replications. After treatment, numbers of germinated and established seedlings were counted in 1 and 3 weeks, and dry matter was

also weighed on 3 weeks.

Petri dishes were used with filter papers in the experiment. Nitrofen, oxadiazon, benthiocarb, amiben, alachlor, butachlor and diuron were treated at 1,10 and 100 ppm solutions on January 8, 1982, to Mimosa seeds which had been put into dishes after soaking in boiling hot water for 5 min to brak dormancy. Twenty seeds were sown in each dish with 5 replications. After treatment, the number and length of germinated seedlings was counted on 1 or 2 weeks.

Growth regulator applications in petri dishes :

Petri dishes with filter paper were used in this experiment. Solutions of 2,4-D amine salt, ethephon, IAA, NAA and $GA_3$ were treated at 0.1,1,10. 100 and 1000 ppm on October 15 and November 3, 1981, to Mimosa seeds which had been put into dishes after soaking in boiling hot water for 5 min to break dormancy. Twenty seeds were sown in each dish with 5 replications. IAA and NAA were solved into ethyl alcohol 10 ml with Tween 20 1 drop and emulsified into distilled water to make solutions. The number and length of germinated seedlings were counted on 1 and 2 weeks after treatment.

The effect of mixing IAA and NAA with alcohol and Tween 20 on Mimosa germination was tested on January 25, 1982, after boiling seeds for 5 min to break dormancy. Twenty seeds were sown in each petri dish with 5 replications. The number and length of germinated seedlings were counted on 1 or 2 weeks after treatment.

Pre-and post-emergence herbicide applications for dormant (unboiled) seeds :

Pre-and post-emergence herbicide solutions were treated to dormant seeds during 1 day at concentrations of 0.1 and 1% on September 21, 1982. Treated seeds were dried up 1 day in air dry condition, and then, without washing, soaked in boiling hot water for 5 min to break dormancy. These seeds were sown in sand of small plastic pots, and their emergence and establishment were observed 1 week later. Treated chemicals were ethephon, 2,4-D amine salt, 2,4-D ester, alachlor, butachlor, diuron, benthiocarb, nitrofen, ametryne, atrazine, glyphosate and paraquat.

3. Results and discussion

Pre-emergence herbicide applications in pots :

When the above-mentioned herbicides were tested as pre-emergence in the clay-pots at 0.5 and 1 kilogram (ai)/rai, results indicated that there was no seed germination in the oxadiazon treated pots at both concentrations, while there were germinations on all other treatments except amiben at 1 kg. After 3 weeks, plants in 1 kg treatments of nitrofen, alachlor and diuron were all killed and so did those in the 0.5 kg treatments of amiben, alachlor and diuron. Nitrofen at 0.5 kg and benthiocarb and butachlor at both concentrations were not satisfactory (Table VI-1).

Results of testing on effects of certain herbicides on the germination of Mimosa seeds in vitro indicated that amiben markedly reduced both root and shoot growth to less than 10% at 1 ppm, alachlor, butachlor and benthiocarb also limited the root growth to less than 40% at 1 ppm, while nitrofen, oxadiazon, and diuron produced the same effect at 100 ppm. As for effect on shoot growth, nitrofen was effective at 1 ppm reducing shoot

growth to less than 40% while benthiocarb, butachlor, alachlor were as effective at 10 ppm and oxadiazon at 100 ppm and diuron had no noticeable effect at the three concentrations tested (Figure VI-1, VI-2).

Growth regulator applications in petri dishes :

Results revealed that one week after seeds of Mimosa pigra were treated with 0.1,1,10,100 and 1,000 ppm of 2,4-D, IAA, ethephon, NAA and $GA_3$, there were marked retardation of shoot and root elongation of those treated with 2,4-D, IAA, ethephon and NAA. The effect was most pronounced at the concentration of 100 ppm and above for 2,4-D and above 100 ppm for the rest. As for $GA_3$ it promoted shoot and root elongation of Mimosa pigra at the concentration above 1 ppm, but at the concentrations of 100 ppm and above it inhibited, root growth (Figure VI-3, VI-4).

Adding of Tween 20 1 or 2 drops into solution had little effect for Mimosa germination, but ethyl alcohol had severe effects for it at concentrations of 1 to 10% (Figure VI-5).

Table VI-1. Effect of pre-emergence herbicides on Mimosa pigra germinination

| Treat-ment | nitrofen | | oxadiazon | | benthiocarb | | amiben | | alachlor | | butachlor | | diuron | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kg/Rai | 0.5 | 1.0 | 0.5 | 1.0 | 0.5 | 1.0 | 0.5 | 1.0 | 0.5 | 1.0 | 0.5 | 1.0 | 0.5 | 1.0 |
| G1 | 93.62 | 89.34 | 0 | 0 | 95.72 | 102.11 | 68.09 | 0 | 114.87 | 68.09 | 123.26 | 114.87 | 114.87 | 112.76 |
| G2 | 19.23 | 0 | 0 | 0 | 62.5 | 37.5 | 0 | 0 | 0 | 0 | 123.26 | 114.87 | 0 | 0 |
| D.M. | 7.69 | 0 | 0 | 0 | 84.61 | 15.38 | 0 | 0 | 0 | 0 | 61.53 | 53.84 | 0 | 0 |

Note: Application rate of herbicides were 0.5, 1.0 kg(ai)/rai (3.125, 6.25 kg/ha)

G1 = percentage of germination at 1 week

G2 = percentage of germination at 3 weeks

D.M = percentage of dry matter at 3 weeks

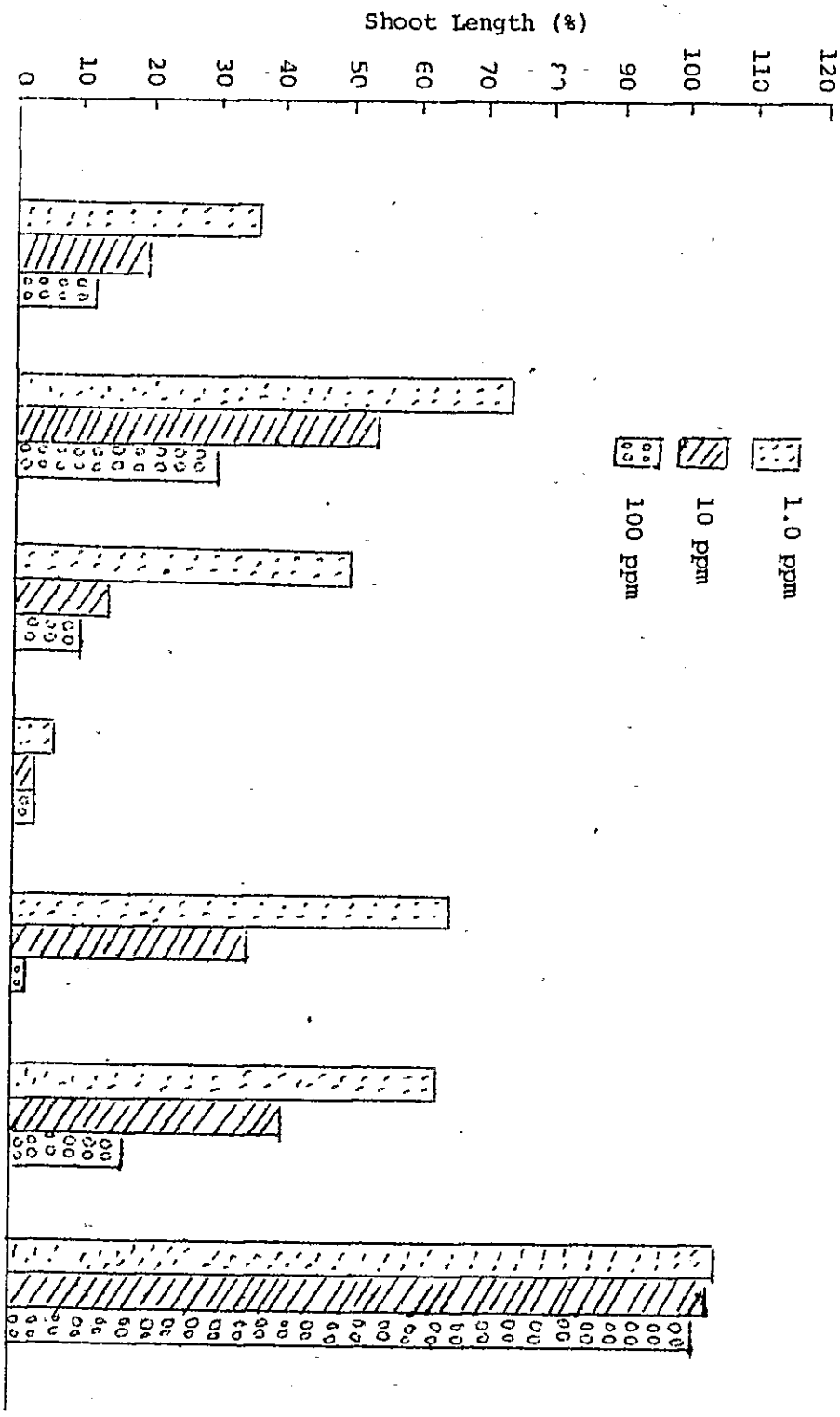



Figure VI-1. Effect of pre-emergence herbicides on Mimosa germination in vitro (shoot length).

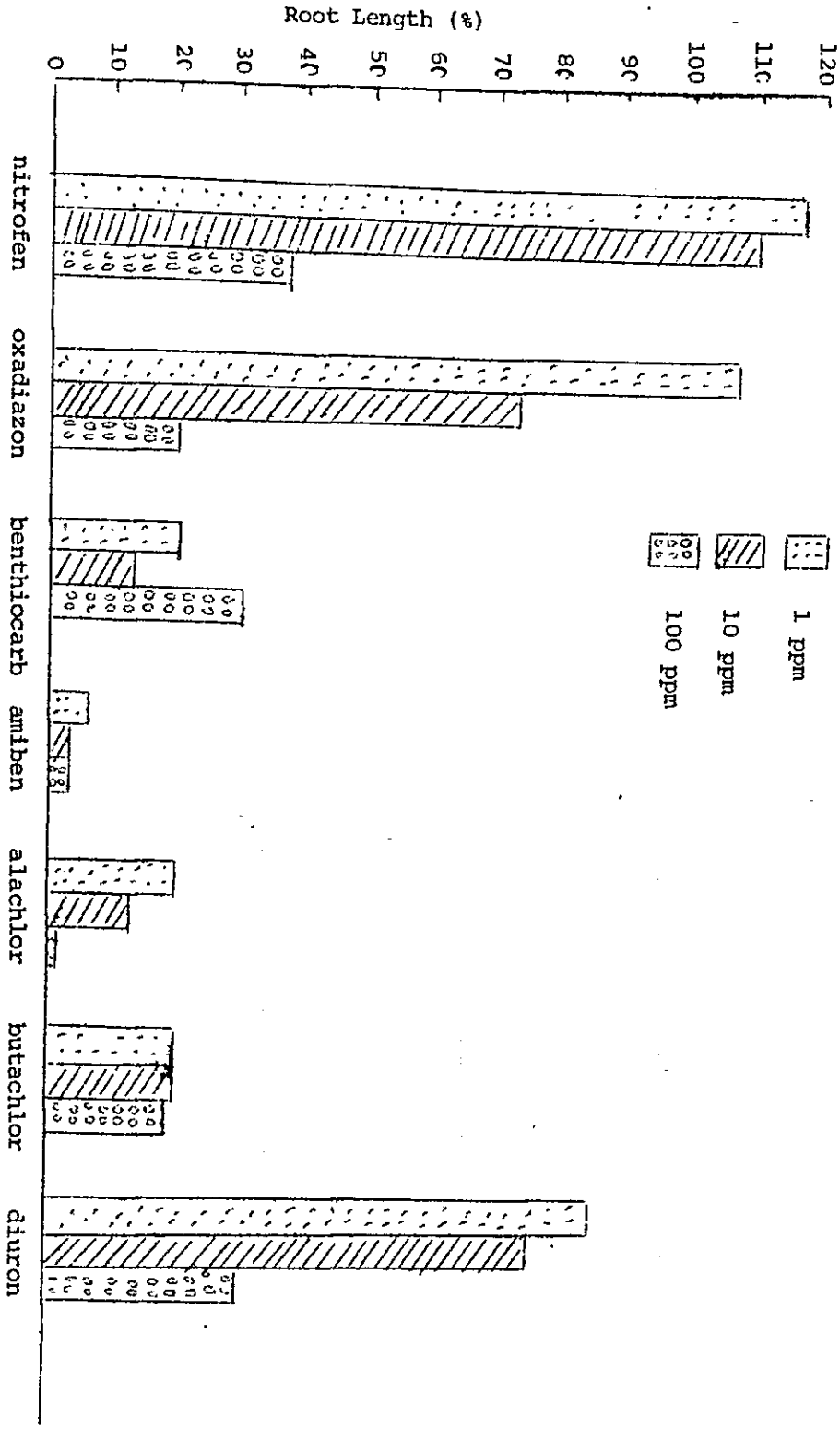



Figure VI-2. Effect of pre-emergence herbicides on Mimosa germination in vitro (root length)

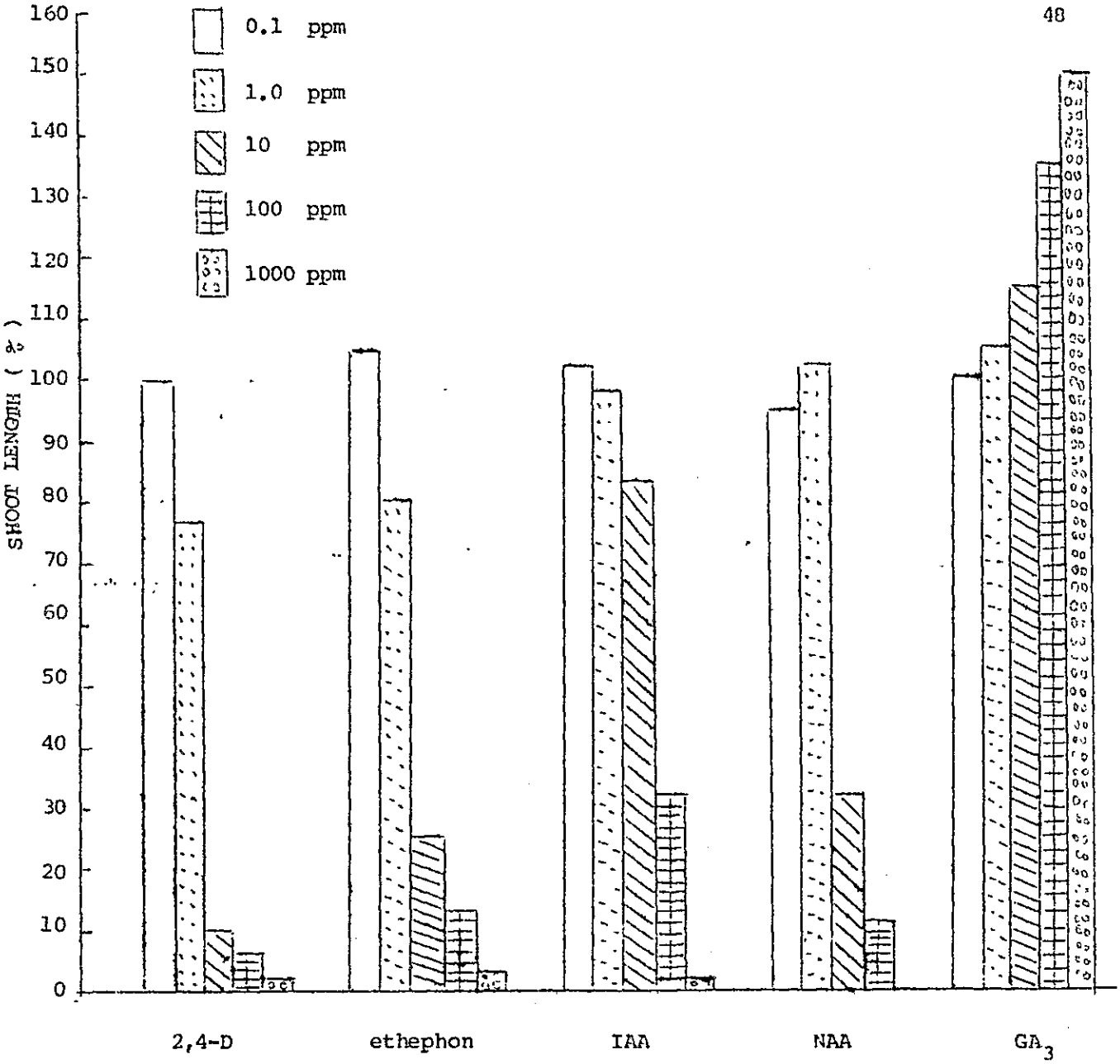



Figure vI-3. Effect of growth regulators on Mimosa germination in vitro (shoot length)

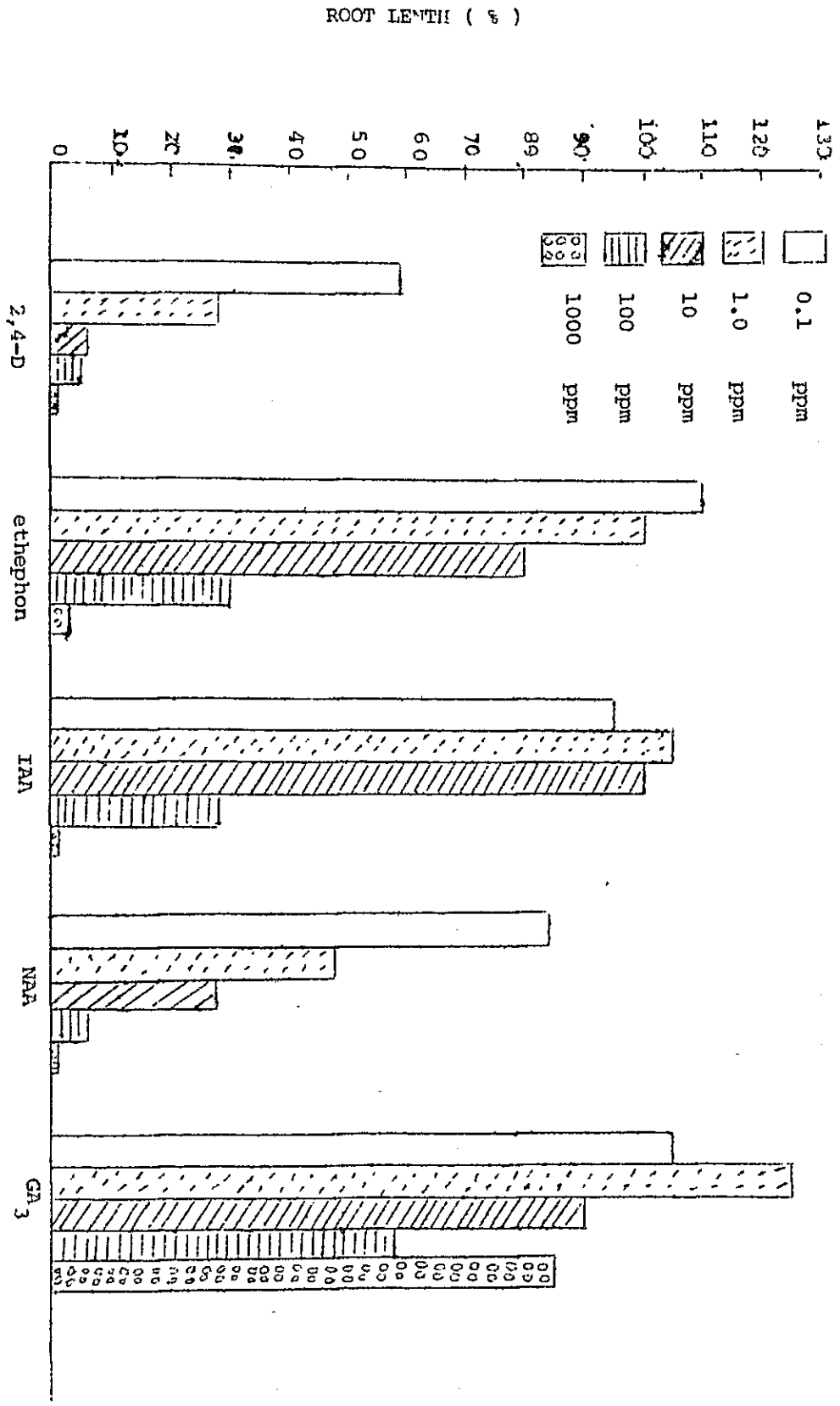



Figure VI-4. Effect of growth regulators on Mimosa germination in vitro (root length)

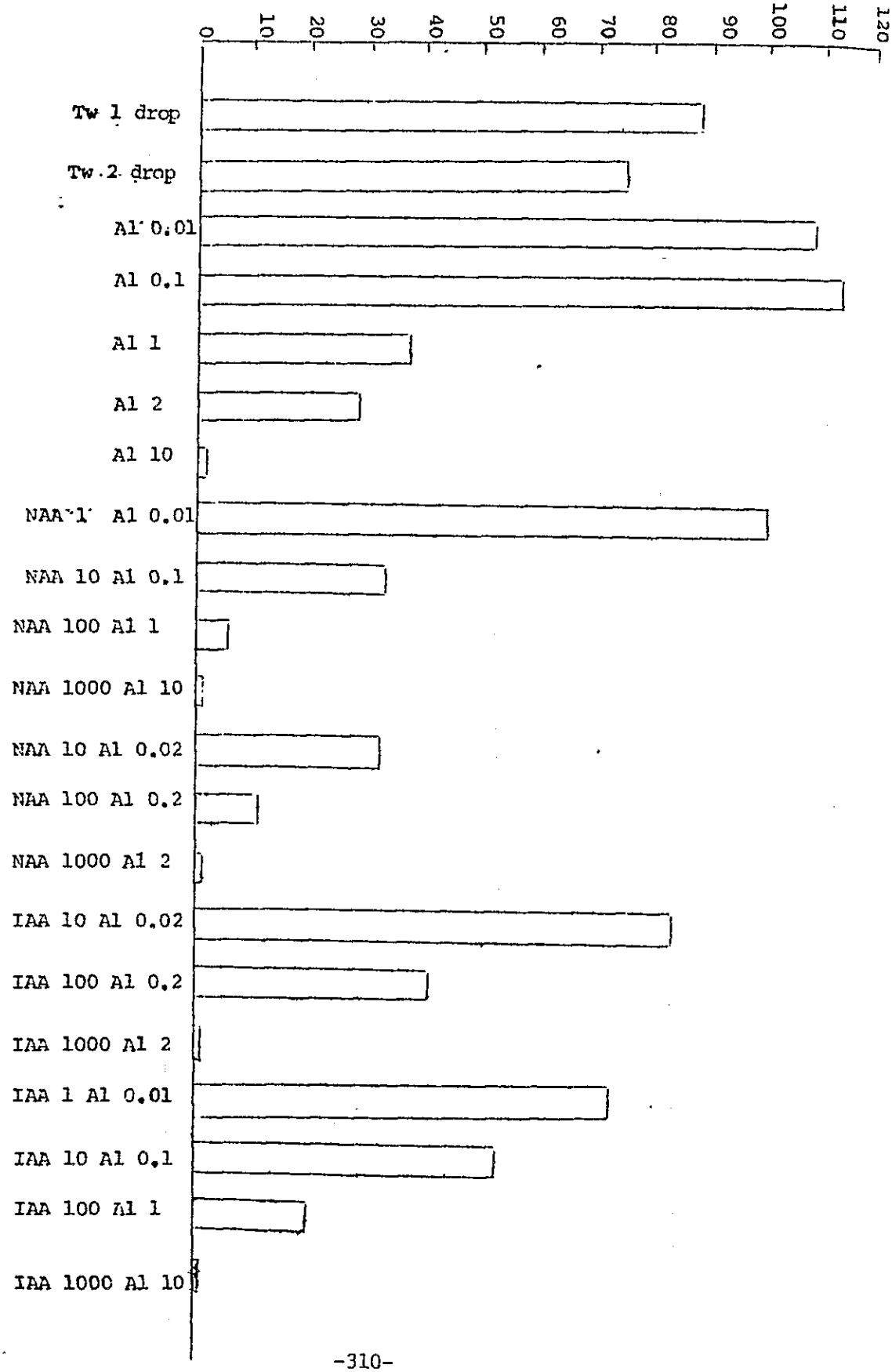



Figure VI - 5. Effect of Alcohol (Al) and Tween 20 (Tw) on Mimosa germination in vitro (Shoot length)

Note : NAA and IAA ... 1, 10, 100, 1000 ppm

Alcohol ... 0.01, 0.02, 0.1, 0.2, 1, 2, 10 %

Pre- and post-emergence herbicide applications for dormant seeds :

On one week after sowing (8 days after treatment), it was found that 2,4-D ester strikingly inhibited the emergence, and reduced shoot and root growths of seedlings. Nitrofen also caused severe reduction of shoots. Butachlor and diuron treated plants wilted soon after their emergence and died later. Benthiocarb caused severely stunted shoots and strubbed roots.

However, in ethephon, alachlor, glyphosate and paraquat treated plants, there were no visible toxic symptoms caused by chemicals, although glyphosate was reported by some officials as one of excellent post-emergence herbicides for Mimosa pigra control (Figure VI-6).

The effect of these chemicals to break seed dormancy was not observed in this experiment. So, for controlling seed germination of Mimosa pigra, 2,4-D ester or a few other chemicals may be effective, even when they are sprayed on dormant seeds.

By these experiments, as a conclusion, 2,4-D might be most useful to apply for controlling the germination of dormant or dormancy-awakening Mimosa seed, but glyphosate, which was considered to be the most promissing herbicide as post-emergence (8), was found to be ineffective for controlling it. Therefore, the mixture of both herbicides may be interesting to test to control Mimosa vegetation and its subsequent seed germination.

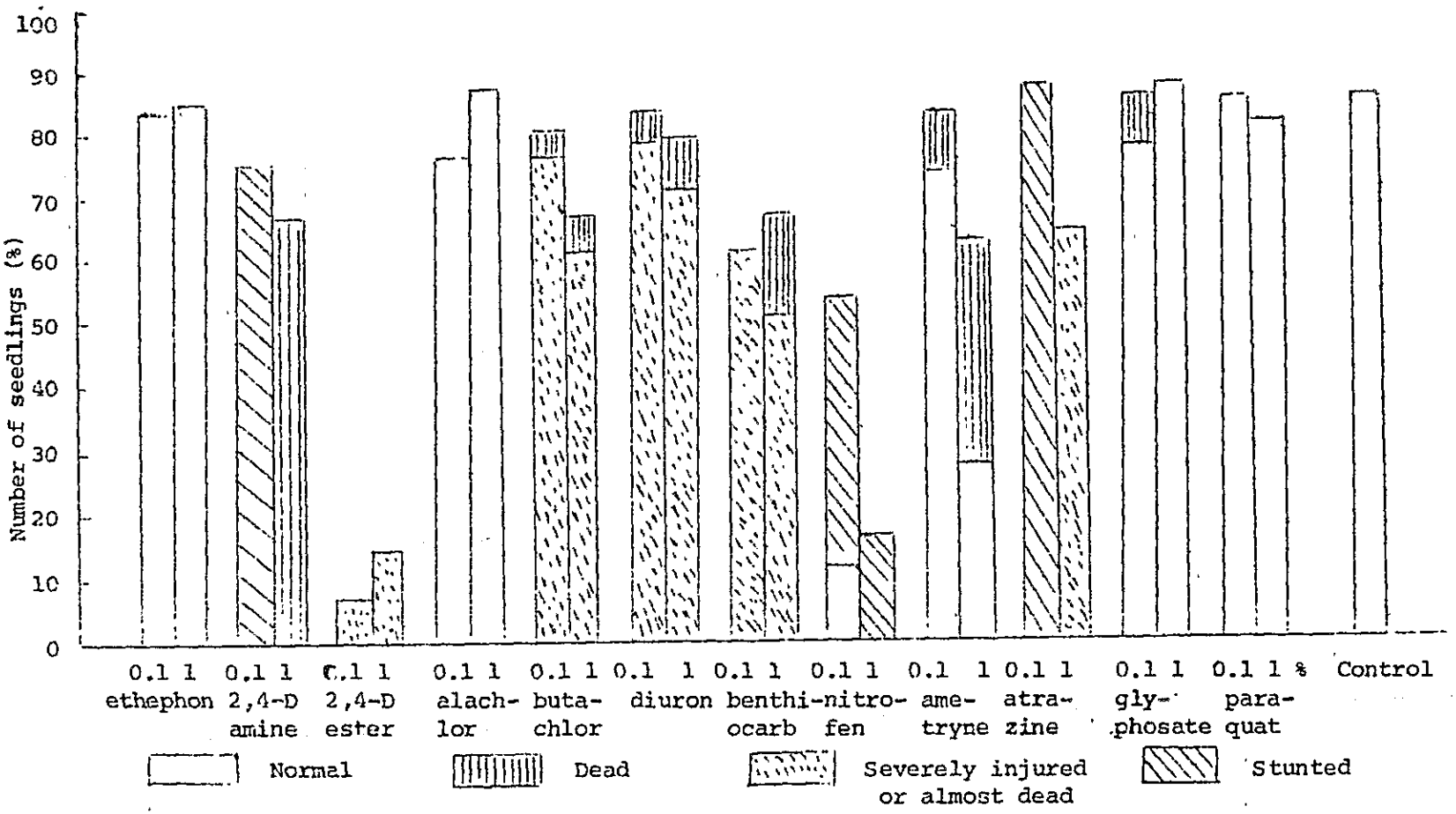



Figure VI-6. Number of seedlings 8 days after herbicide treatment. Dormant seeds were soaked in solutions of herbicides for 1 day, dried up 1 day and sown in sand after breaking dormancy by hot water.

# VII. ANATOMICAL EFFECTS OF HERBICIDES AND WATER FLOODING ON MIMOSA PIGRA L.

Hidejiro SHIBAYAMA and Kanika PIENPUCK

## 1. Introduction

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

## 2. Materials and methods

This work was conducted from October of 1981 to February of 1983. Mimosa 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 Mimosa seedlings of 30 to 40 cm in height, at doses of 0.563, 1.125, 2.25 and 4.50 kg(ai)/ha by data of Kittipong (8). Treated leaves were collected almost on 1 day to 1 week after treatment and fixed in FAA solution.

In water-flooding experiment, Mimosa seedlings were flooded by tap water after growing under upland condition for about 1 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 Mimosa 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.

3. Results and discussion

Herbicide treatment :

By treatments of glyphosate and 2,4-D amine salt, cytoplasm and plastids of palisade and spongy cells of Mimosa leaves decreased strikingly, but there was little change on the structure of each cell (Plate 17, 18, 19). After leaf-burning by 2,4-D amine treatment, sometimes, leaves were observed to be shrunk (Plate 20). In the growing point region of shoot, many cells of leaf primordia or other tissues were completely vacuolated by treatment (Plate 21). Within 2 or 3 weeks after herbicide treatment, damaged leaves usually became yellow and brown and then fell down on the ground. About herbicidal effects on anatomy of shrub tree, Morey (11) reported that primary and secondary growths of mesquito tree were inhibited by fosamine. However, it was not clear in this study how glyphosate or 2,4-D would inhibit the growth of Mimosa stem.

Water-flooding treatment :

Water-flooding treatment has caused the formation of spongy tissue from the periderm of bark of Mimosa roots. As primary tissues, epidermis

and cortex were used to be crushed by the secondary growth of stele in upland soil, but, in flooded soil or flooded water, they were still existing at early stage of the secondary growth (Plate 22,23,24). Cork cell layers were found in roots of flooded condition (Plate 23), but they were peeled off in those of upland condition (Plate 22).

Morphological difference of roots in both conditions may show the physiological adaptation of Mimosa roots to aquatic and upalnd conditions. However, the mechanism of adaptation was not cleared yet.

## VIII. GENERAL DISCUSSION

About the Mimosa pigra L. problem in Thailand, authors are afraid that it will infest the more aquatic areas in future in any parts of Thailand including central region. However, this species may not be successful to infest main streams of big rivers such as the Chao Phraya or the Khong Rivers, because its seed can not germinate and establish at water-logged areas. Also, this species can not infest natural forests in mountains or agricultural lands under cultivation.

By results on germination experiments, Mimosa seeds will break their dormancy the more in northern temperature condition than that of Bangkok area. This phenomenon may show one of adaptabilities of this species to northern region.

On controlling methods of Mimosa pigra, authors conducted only pre-emergence application of herbicides in this study, because many researchers already conducted excellent studies in Thailand on post-emergence application of herbicides. So, by our experiment, we can find only that pre-emergence application of herbicides will be useful for some occasions as mentioned before.

About the scanning electron microscopic (SEM) and anatomical works, authors found some interesting in physiological problems on seed germination and herbicidal action to Mimosa shoots, but these should be studied in future.

The utilization of Mimosa pigra was not the objective of this study. However, for the long-term management of Mimosa pigra, this kind of researches (23, et al.)will be more important from now on.

## IX. SOME SUGGESTIONS FOR *MIMOSA PIGRA* L. MANAGEMENT

For the long-term management program of *Mimosa pigra* L., authors' conclusions were as follows :

1) The complete eradication of *Mimosa pigra* from the specific area should not be the aim of control project, because it would need the more amount of chemicals and would make damages to environmental conditions, too.

2) This program should not be terminated in a short time, because it was the good time to keep the area from *Mimosa*'s regrowth or reinfestation in the low cost when major part of its vegetation had been controlled and also because it would take long time until the biological suppression of *Mimosa* by insects or plant pathogens would become practically successful.

3) The intergrated control of *Mimosa pigra* should be conducted by combining together pre-and post-emergence application of herbicides, mechanical or hand-weeding method, water level management, biological agents and other methods.

4) The utilization of *Mimosa* should be very important and be studied in various ways.

## X. SUMMARY

1. Distribution and habitats of Mimosa pigra L. in Northern Thailand

Mimosa pigra vegetations were found mainly in the Northern Region, but they were also found along the Chao Phraya River down to near Nakorn Sawan, or several spots in the Central Region.

On habitats of this species, plants were usually growing at marginal areas of canals, rivers and lakes, but they also inhabited water-logged areas as in some reservoirs.

Mimosa infested lots of abandoned fields and roadsides, too, especially around Chiangmai city.

2. Effects of soil conditions and water levels on seed germination and establishment of Mimosa pigra L.

Mimosa pigra was found to germinate from soils of various locations, within the soil depth of 7 cm.

By the water level experiment, Mimosa seeds could germinate even under 10 cm water depth, but their roots could not grow into soil when soil was flooded by water. These germinated seedlings floated up to the water surface and decayed to die later. They can germinate and establish only under upland soil condition.

After establishing under upland condition, Mimosa seedlings were very tolerant to water-flooding.

3. Effect of temperature and some other factors on seed germination of Mimosa pigra L.

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. Low temperatures as 5 and 10 C of incubator experiment were also very effective for breaking dormancy of old seeds, but, as temperature was the higher, the germination rate was the lower. 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.

Conc. $H_2SO_4$, burning by flame, scrubbing by sand paper and 99.8% acetone were also effective for breaking dormancy of seeds. Old seeds collected in 1981 showed higher germination rate than new seeds collected in 1982, when they were tested in 1982. Wet-stored seeds germinated more than air dry-stored ones.

4. Scanning electron microscopic observations on seed coat of Mimosa pigra L.

When vaselline was coated at the top, middle or base end of each seed after various treatments for breaking dormancy, seeds showed different abilities to absorb water and germinate by treatments. Seeds of boiling hot water, alternating temperature, burning and 99.8% acetone germinated a little or none, when their base ends were pasted by vaselline, but those of conc. $H_2SO_4$ and sand scrubbing could germinate even when base ends were coated by it. There are strophiole, hilum and micropyle

at the base end of Mimosa seed. So, treatments for breaking dormancy seemed to be effective to change the abilities of these tissues to absorb water by scanning electron microscopic (SEM) observations. On the other hand, they seemed to be ineffective for enhancing the absorption of water through other parts of seed coat, besides conc. $H_2SO_4$ and sand scrubbing treatments.

5. Effects of herbicides and growth regulators on seed germination and emergence of Mimosa pigra L.

Nitrofen, oxadiazon, benthiocarb, amiben, alachlor, butachlor and diuron were treated as pre-emergence herbicides in pot and petri dish experiment. There was no seed germination in the oxadiazon treated pots while there were germinations on all other treatments except amiben at 1 kg(ai)/rai. After 3 weeks, plants in 1 kg treatments of nitrofen, alachlor and diuron were all killed and so did those in the 0.5 kg treatments of amiben, alachlor and diuron. In vitro experiment, amiben was most effective among them for inhibiting germination. On growth regulators, 2,4-D was more injurious to germination than ethephon, IAA, NAA and $GA_3$.

Herbicide treatments before breaking seed dormancy revealed that 2,4-D ester strikingly inhibited the seed emergence, but that post-emergence herbicides as glyphosate and paraquat did not cause any toxic symptom for germination.

6. Anatomical effects of herbicides and water flooding on Mimosa pigra L.

By treatments of 2,4-D amine salt and glyphosate, cytoplasm and plastids of palisade and spongy cells of Mimosa leaves decreased strikingly, but there was little change on the structure of each cell. In the growing point region, many cells of leaf primordia were completely vacuolated by treatments. After leaf-burning by 2,4-D amine treatment, sometimes, leaves were observed to be shrunk. Within 2 or 3 weeks after these treatments, damaged leaves used to become yellow and brown, and then fall down on the ground.

Water-flooding treatment caused the formation of spongy tissue from the periderm of bark of Mimosa roots.

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Plate 1. Aerial view of Doi Tao area of Bhumipol dam reservoir.

Plate 2. Ibid. The upper part of *Mimosa* vegetation was burned by flooding.

Plate 3. Kiu Lom dam reservoir.

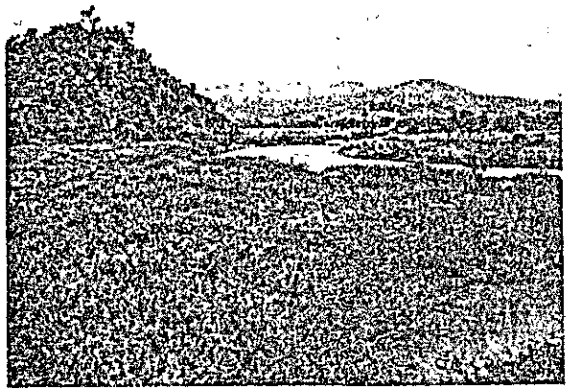

Plate 4. Ruak River at Golden Triangle.

Plate 5. Ping River at Chiangmai.

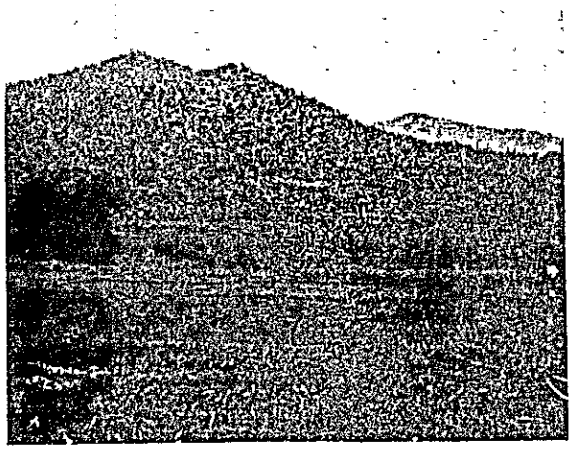

Plate 6. The upstream of Lao River.

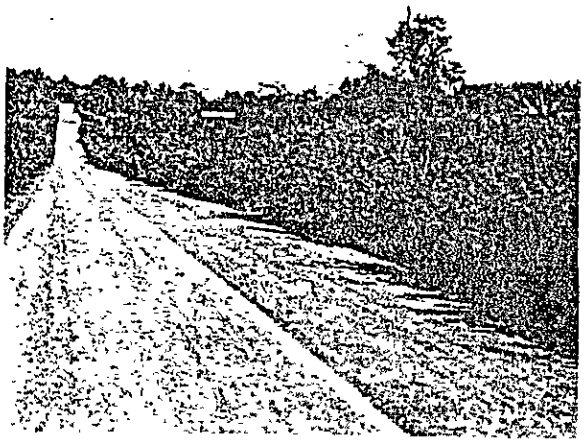

Plate 7. *Mimosa* vegetation at road side.

Plate 8. Hand-weeding of *Mimosa* seedlings.

Plate 9. Completely killed *Mimosa* plants after flooding.

Plate 10. Colour-analyzed satellite picture of Kiu Lom dam reservoir.

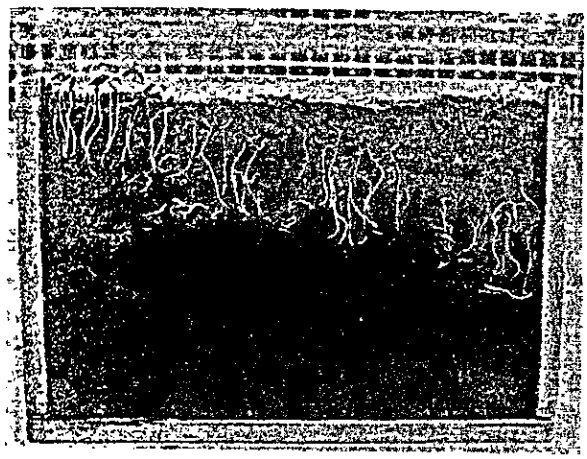

Plate 11. Emergence of *Mimosa* seedlings from soil.

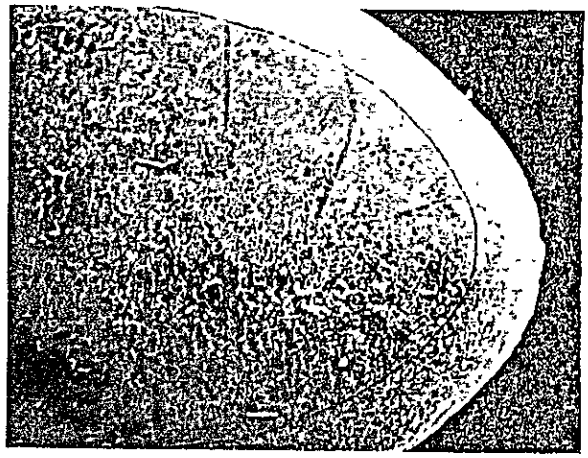

Plate 12. Surface of *Mimosa* seed coat (by SEM).

Plate 13. Strophiole and hilum of untreated seed (by SEM).

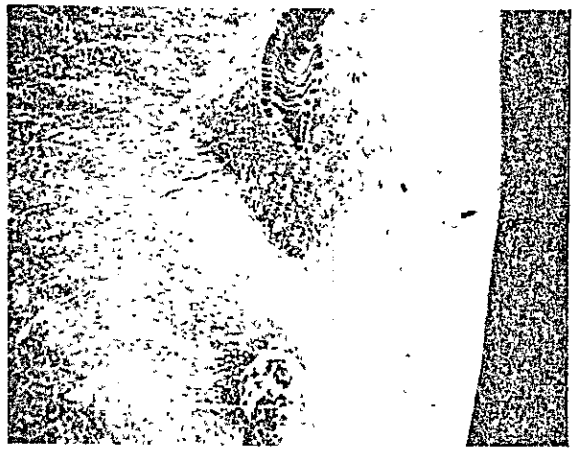

Plate 14. Strophiole and nilum of boiled seed (by SEM).

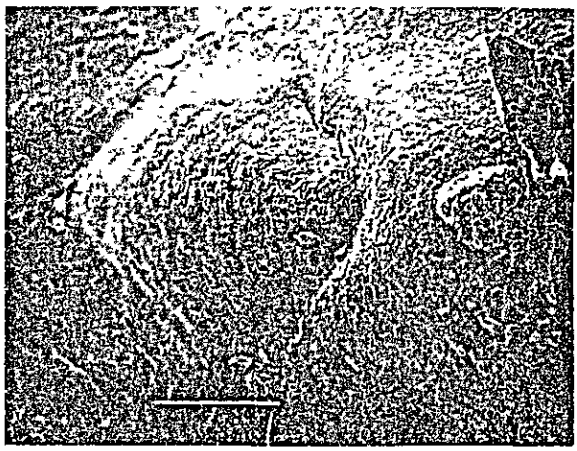

Plate 15. Strophiole and hilum of low temperature treated seed (by SEM).

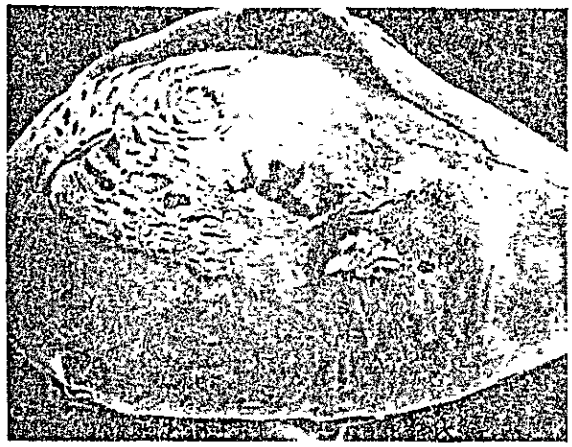

Plate 16. Conc. $H_2SO_4$ treated seed (by SEM).

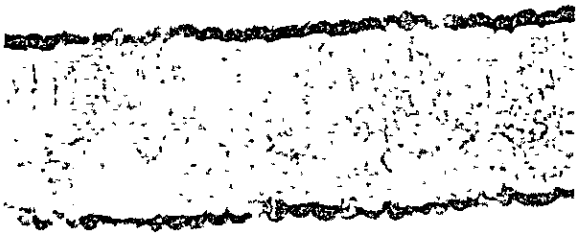

Plate 17. Untreated leaf.

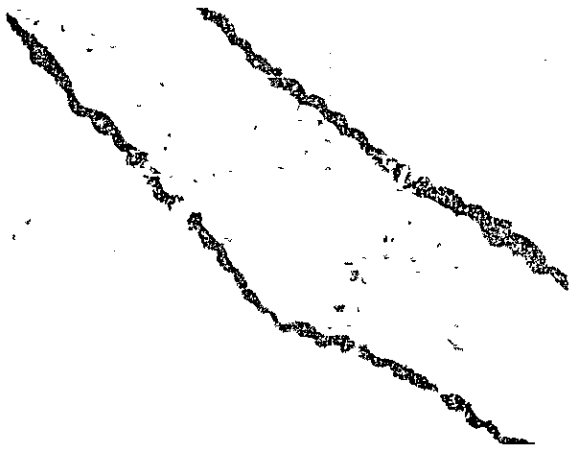

Plate 18. Leaf treated by glyphosate.

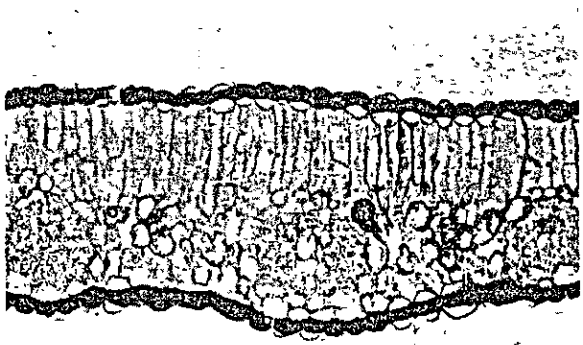

Plate 19. Leaf treated by 2,4-D.

Plate 20. Shrunk leaf treated by 2,4-D.

Plate 21. Shoot apex treated by 2,4-D.

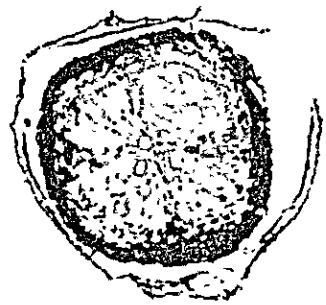

Plate 22. Root in upland soil.

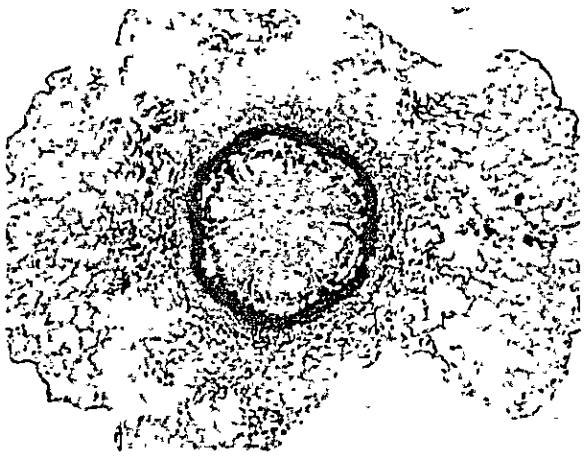

Plate 23. Root in flooded water.

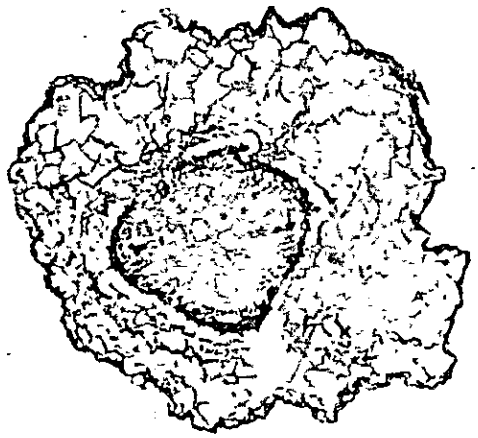

Plate 24. Secondary root in flooded soil.