Secretariat Phytotronique
Phytotron - C.N.R.S.
91190 Gif-sur-Yvette

Gif-sur-Yvette, February 1975

PHYTOTRONIC NEWSLETTER N°9

CONTENTS

I. EDITORIAL

The difficulties which science throughout the world is going through as a result of the world wide economic crisis makes working conditions as difficult for scientists, technicians, manufacturers of material for environmental conditioning as for those who use these materials or practice it. It is therefore not surprising that our Bulletin which provides technical, scientific and practical information has been a success, judging by the large amount of mail and encouragement which we receive.

Above all, and to keep the promise that we made in the last Bulletin (No 8)here is the list of yearly expenses and amounts received in French francs for voluntary contributions for the cost of publishing and distributing the PHYTOTRONIC NEWSLETTER, as well as the list of individuals, companies, associations or universities that sent us funds.

Year	Expenses		Amounts received	
1971	841,35	F.F.		
1972	7 798,15	"	474,--	F.F.
1973	6 199,50	"	2 988,36	"
1974	10 362,10	"	745,24	"

The amounts received were donated by : Percival Manufacturing Co. (USA) - Hokkaido National Agric. Station (Japan) - Station d'Amelioration des Plantes, Gembloux (Belgium) - Commonwealth of Australia - Ets Ruthner, Vienna (Austria) - Agricultural Research Council, London (Great Britain) - Westinghouse Electrical Corp. (USA) - CNIH, Paris (France) - Compte des Plastiques (France) - Ets l'Humidifere (France) - Heraeus (France) - Ets Tezier Freres (France) Ets Sapratin (France) - Mr Scialom (France) - Association Sport-Culture, Chateaulin (France) - Ets L. Boullet (France) - Ets R. Haag (F.R. Germany) - Nagoya University (Japan) - Duke University (USA) - N.C. State University (USA).

As you can see for yourselves, the financial aid that we receive, and again for which we thank each of you, does not cover even a quarter of our expenses, even if we add the flattering requests received to exchange our Bulletin with some French or foreign journals.

However that may be, when our readers send us personal financial aid or through official or private organizations, please send your donations to us filling in the cheques or money orders in the name of :

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with the endorsement : Participation aux frais de parution du Bulletin "PHYTOTRONIC NEWSLETTER".

Thank you in advance

The contents of this issue of our Bulletin are, as usual, polyvalent so that we can reach a fairly large number of people interested in plant biology.

In order to satisfy a large number of readers we are also listing the lectures given in Raleigh-Durham in May 1972 (an analysis can be found in Bulletin N°3) and are also giving references where the integral texts can be Found. For the few lectures which have not been published to date, we expect to print them if the authors send them to us. In the present issue we are able to reprint an article by B.S. VERGARA = Rice Physiology, and at the same time wish much success to the Phytotron of the International Rice Institute of the Philippines which was just inaugurated. (See Bulletin N° 8).

The minutes of a Symposium which we found interesting, although it took place a while ago, is that of Silsoe, September 1973 : Greenhouse Design and Environment.

Under the heading Phytotronic Research is a paper from P.J. KRAMER : Comparison of plant growth in the field and in a phytotron, an important topic on which many researchers hold differing opinions.

A report on Phytotronics at the Botanical Conference in Leningrad (July 1975) proposes to our readers the joint organization of round table discussions on Phytotrons or the inauguration of discussions on subjects dealing with Phytotronics.

Finally, as concerns horticultural practice, the discussion on greenhouse lighting for plants is taken up again with a report by J.A.C. WEIR : Commercial application of sodium lighting for plant growth in United Kingdom.

In conclusions, we again ask to be informed of all events taking place and news or papers which might be of interest to our readers.

Thank you in advance.

P. CHOUARD and N. de BILDERLING

II. REFERENCES FOR LECTURES GIVEN IN RALEIGH-DURHAM (USA) in May 1972

As a result of the publication of Bulletin N°3 (October 1972) many readers wrote asking either for copies or for information as to where the texts of the lectures were published. After much investigation the Phytotronic Secretariat is happy to be able finally to publish the list below of the lectures with references. Some, which were never published and which are of current interest, will be printed in the coming issues of our Bulletin.

Until then, here is the list :

PART I. A. The Strategy of Phytotron Research

1) P. CHOUARD (France) - The Impact of phytotrons and phytotronics on plant physiology. Text never published but a more complete contribution was published under the title "Phytotronique" in the volume Organum (N°20 and the last) of Encyclopedia Universalis, Paris, 1973-74, pages 499-505. See also Phytotronic Newsletter N°8, October 1974.

2) K.J. MITCHELL (New Zealand) - Correlation of controlled environment research with field research.

Published in N.Z. Agricultural Science, Vol. 8, N°2, May 1974.

3) C.D. RAPER (USA) - Cost to benefit evaluation of Phytotron research versus field research.

Published in Agronomy Journal, Vol. 65, Sept.-Oct. 1973, pp. 701-705.

4) R.J. BULA (USA) - Complementary aspects of phytotron and field research. Published in Agricultural Science Review, 1973, Vol. 11, N°1, pp. 1-6.

B. The degree of control provided and needed in controlled environment facilities

1) C.H.M. Van RAVEL and K.J. Mc CREE (USA) - Design and use of phytotrons in crop productivity research.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

2) P. GAASTRA (The Netherlands) - Physiological aspects of environmental control in climate rooms.

Not published.

3) G.J. HOFFMAN (USA) - Humidity effects on yield and water relations of nine crops.

Published in three papers :

- Water relations and growth of cotton as influenced by salinity and relative humidity. Agronomy Journal, 1971, Vol. 63, N°493, pp. 822-826.

- Growth and water potential of root crops as influenced by salinity and relative humidity. Agronomy Journal, 1971, Vol. 63, N° 505, pp. 877-880.

- Humidity effects on yield and water relations of nine crops. Transactions of the ASAE. 1973, Vol. 16, N°1, pp. 164-.167.

4) Y.B. SAMISH (USA-Israel) – CO_2 measurement and control in growth chambers. The need and technique.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

5) K.J. McCREE (USA) - A rational definition of photosynthetically active radiation.

Published in three papers :

- Test of current definitions of photosynthetically active radiation against leaf photosynthesis data. Agric. Meteorology, 1972, 10, pp. 443-453.

- The measurement of photosynthetically active radiation. Solar Energy, 1973, Vol. 15, Pp. 83-87.

- A rational approach to light measurements in plant ecology. Current Advances in plant science, 1973, N°5, pp. 39-43.

6) R.L. SCHAFER (USA) - Computer based data acquisition and process control.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

PART II. Examples of Problems to which Phytotrons can make useful contributions

A. Responses of specific Crop Plants

a) 1st session

1) J.R. Mc WILLIAM (Australia) Adaptation to temperature stress in plants.

Not published.

2) A. ULRICH (USA) Controlled environments in crop production research : sugarbeets, tomatoes and strawberries.

Not published.

3) D.P. ORMROD (Canada) - Responses of pea plants to temperature in controlled environments.

This paper was a compilation of the following texts

- Responses of peas to environment. Canadian Journal of plant Science, 1966, Vol. 46, pp. 77-85 and 195-203.

- Shoot apex development in *Pisum sativum* L. as affected by temperature. Canadian Journal of Plant Science, 1970, Vol. 50, pp. 201-202.

- Temperature and humidity effects on the growth and yield of pea cultivars. Canadian Journal of Plant Science, 1971, Vol. 51, pp. 479-484.

4) G. HOFSTRA, G.J.A. RYLE and R.F. WILLIAMS (Canada) - Effects of extending the day length with low intensity light on the growth of wheat and orchard grass.

Published partly in the Australian Journal of Biological Sciences, 1969, Vol. 22, pp. 333-341 and partly in the Canadian Journal of Plant Science, 1972, Vol. 52, pp. 535-543.

5) G.J.A. RYLE, E.L. LEATE, M.J. ROBSON and J. WOLEDJE (United Kindom) - Research in controlled environments in relation to the perennial grasscrop.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

6) B. BRETSCHNEIDER-HERRMANN (Germany, Fed. Rep.) - Growth development and yield of different spring-wheat varieties grown under field conditions and under different climatic conditions in the Phytotron (.day length-temperature trial).

Partly published in Dr Ahmad Babaey's Dissertation, Giessen, 1973 : "Untersuchungen uber Entwicklung des Produktivitatstyps Sommerweizen mit besonderer Berucksichtigung von Photoperiode and Temperatur".

b) 2nd session

1) N.J. LASPERBAUER (USA) - Effect of pretransplant environment on post-transplant growth and development of tobacco.

Published partly in Agronomy Journal, 1973, Vol. 65, PP. 447-450.

2) B.S. VERGARA (Philippines) - Controlled environments in the study of rice physiology.

We are publishing this paper in this issue (see Part V). (p 17).

3) P. De T. ALVIN, A.D. MACHADO and F. VELLO (Brazil) - Physiological responses of the cacao to environmental factors.

Published in the Proceedings of the 4th International Cocoa Research Conference (January 9-18, 1972) Trinidad. Edited by D.B. Murray, University of the West Indies.

4) U. MORENO (Peru) - Research in environmental plant physiology without controlled environment equipment.

Not published.

5) C.A. FRANCIS (Columbia) - Effects of photoperiod and temperature on maize growth in the field in Columbia.

Published in the 1972 Proceedings of the Annual Corn and Sorghum Research Conference, pp. 119-131.

B. Use of Phytotrons in Different Disciplines

a) 1st session

1) J.A. TEERI (USA) - Field and Phytotron studies on the ecology of natural populations.

Published in Ecology, 1974.

2) F.E. ECKARDT (France) - Contributions of Phytotron research to the understanding of the functioning of photosynthetic systems in the natural environment.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

3) W.W. HECK (USA) - Air pollution research on plants in Phytotrons.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

4) H. HELLMERS (USA) - Use of controlled environments in research in tree physiology.

We hope to publish this paper in one of the coming Phytotronic Newsletters.

5) C.E. MAIN (USA) - Use of phytotrons for phytopathological research.

Not published. Anyone interested in obtaining a copy of the paper may contact the author directly at North Carolina State University, Raleigh, North Carolina, USA.

b) 2nd session

1) J. Mc NEIL (USA) - Role of four factors and their interactions in diapause initiation of two hyperparasites of tobacco hornworm Manduca sexta L.

Partly published in Journal of Insect Physiology, 1973, Vol. 19, PP. 2107-2118.

2) F.C. STEWARD (USA)-Environments, nutrients, metabolites, development.

Not published.

3) J. HESKETH (USA) - The use of controlled environments to develop computer models describing plant growth.

Published partly in Crop Science, 1972, Vol. 12, pp. 431-435 and 1972, Vol. 12, pp. 436-439 and partly in Environm. Control. in Biol., 1973, Vol. 11, PP. 51-53.

4) R. SLATYER (Australia)-Brief observations on the symposium.

Published in Nature and Resources, 1974.

PART III. Discussion of Problems in the Construction and operation of Phytotrons

1) T. SMITH (USA) - Maintenance operations of the Sepel Laboratories.

Not published.

2) T. MATSUI and H. EGUCHI (Japan) - Some problems in the analysis of the temperature effects on plant growth and differentiation, and automatic program regulation of plant growth by temperature control using a computer system.

Partly published in the following review : Environm. Control. in Biol., 1971, Vol. 9, pp. 37-46 ; 1972, Vol. 10, pp. 105-108 ; 1972, Vol. 10, pp. 21-27 and 1973, Vol. 11, pp. 55-63.

3) H.A. SENN (USA) - Operational experiences with the University of Wisconsin Biotron.

Not published.

4) S. RAJKI (Hungary) - The new Hungarian Phytotron.

Published in Acta Agronimica Acc.d. Scient. Hungarical, 1973, Vol. 22, pp. 295-301.

5) K.J. MITCHELL (New Zealand) - The new Phytotron in New Zealand.

For a copy of this paper contact the author directly at Palmerston North - DSIR - New Zealand.

6) M. IONISHI (Japan) - Phytotrons in Japan.

Published in Environm. Control in Biol., 1972, Vol. 10, N° 3, pp. 91-100.

References of some _papers read by title

1) C. LOPEZ-OCANA (USA) - Effect of thermoperiod on the growth and morphology of Prosopsis tamarugo Phil.

Ph.D. degree Dissertation. University of Nevada, Reno, USA.

2) R.H. HODGSON (USA) - Controlled environment and herbicide metabolism.

Published in two papers Weed Science, Vol. 21, N°6, 1973, pp. 542-548 and Weed Science, Vol. 22, N°3, 1974.

3)B.K. HUANG (USA) - Electronic circumference meter for continuous monitoring of plant and fruit growth.

Published in Journal Series of North Carolina State University, North Carolina, USA, paper N° 3973.

4) H.H. EXETER et al. (USA) - Xenon light and temperature effects on photosynthesis in cucumbers.

Paper N° 71.935 of 1971 Winter Meeting of A.S.A.E. Chicago, Illinois, USA.

5) R.J. CAMERON and D.A. ROOT (New Zealand) - Controlled environment rooms for forest trees.

Published in Climate Laboratory News, N°2, 1974. For a copy of this paper contact directly author at Forest Research Institute, Rotorua, New Zealand.

III. SYMPOSIUM "GREENHOUSE DESIGN AND ENVIRONMENT"
September 18-21, 1973, Silsoe (United Kingdom)

This symposium was organized *by* the International Society of Horticultural Science, and, more specifically by the Commission for

Horticultural Engineering, with L.G. MORRIS as President and A.E. CANHAM as Vice-President and Organizer.

The minutes which follow were based on the text published by A. NISEN in the journal "Pepinieristes, horticulteurs, maraichers" PHM N° 141, November 1 973, pp. 13-19) as well as on the summaries of papers distributed to participants.

The symposium was attended by 75 specialists from 20 countries who are interested in the conception, construction and study of greenhouses and shelters. The subjects discussed were of current interest because, as A. NISEN noted, we all are "in great need of new information /0 that, as soon as possible, we can acquire a better knowledge of the problems posed by the construction and use of modern greenhouses, in the largest sense of the term."

"In addition to the presentation of new scientific studies and achievements, an International Meeting such as this one came up with very advanced syntheses and important conclusions. The reports presented, but above all the discussions which followed and the individual exchange of views between specialists living together for four days in an English college in the country, were fruitful and certainly contributed to the advancement of science in very complex areas, calling for the latest techniques available to researchers".

This meeting also gave participants an opportunity to visit the NIAE (National Institute of Agricultural Engineering), as well as the Experimental Horticultural Station in Lee Valley.

1st SESSION. The control of environment

L.G. MORRIS and T.A. LAWAND shared the presidency of the conference which dealt mainly with the control of temperature and humidity in greenhouses and shelters.

Professor P.C.J. PAYNE, in his opening remarks, retraced the history of the new National Institute of Agricultural Engineering (NIAE), where the symposium took place, which was founded in 1960, and pointed out that the College aims mainly for a multitechnical education for their engineering students.

10 papers were presented at this session.

1. The moisture deficit (21x) controller for greenhouse climate. B.J. HEIJNA (The Netherlands).

The controller is based on the principle that the rate of drying, the same as transpiration, is governed by the moisture deficit and the amount of absorbed radiation. The controller must avoid too high and too low transpiration rates. This "Delta X", as it is called, would give good results in a maritime climate such as in Holland for most crops e.g. : Tomatoes, cucumbers, roses, freesias, and carnations. This apparatus which is unfortunately costly, has sensors as well as a small ventilator placed in a cylinder isolated from radiations.

2. Developments in glasshouse climate control. Th. H. STRIJBOSCH (The Netherlands).

The ventilation and heating of greenhouses are not only used for controlling the temperature of the air in greenhouses, but also to control air exchange which is necessary for the supply of CO_2, indispensible for photosynthesis and for the removal of water vapor emitted by plant transpiration. There was a presentation of different, more and more complex apparatus constructed by Dutch firms, which make it possible to link together diverse climatic factors : pipe temperature, wind velocity and outside temperature, and air humidity. Empirical studies, at first, are currently reviewed with the aid of a digital computer.

3. Comparative measurement of fan and pad cooling and plant wetting. P.A. SPOELSTR.A (The Netherlands).

The ordinary cooling system with horizontal air transfer is connected to a water spray, at the top of the greenhouse (under the greenhouse drain pipes), which assures a horizontal distribution of water sprayed at the top level of the construction. The spraying itself is of the ordinary kind but vertical air movement is assured by means of ventilators. The energy balances registered and the reactions of the plants observed, lead to a certain number of conclusions which are valid for Holland, depending on the period of the year and the plants studied. (Eventually, see Publication N° 80 of the Instituut voor Tuinbouwtechnik Wageningen).

4. Determination of glasshouse heat requirements from temperature and wind records. T.O. FLAHERTY and R. COCHRAN (Ireland).

Observations from 1962 to 1967 (November to March) in six meteorological stations : 3 in Great Britain and 3 in Ireland of hourly registered schedules of temperature and wind velocity. This work made it possible to show, above all, the important differences of "heating deficits" between these regions when the temperature and wind are taken separately, then simultaneously into consideration. A different classification of these stations is also obtained by calculating energy consumption of heat as a factor, or "degrees/hours below 15°C", which, finally, makes possible a better characterization of thermal restraints imposed by the climate on greenhouses and shelters, depending on their location.

5. Design of ducted-air heating systems. B.J. BAILEY (U.K.).

In the ducted-air type of glasshouse heating system inflatable perforated polyethylene ducts are used to distribute warm air throughout the glasshouse. To produce uniformity of temperature the ducts must have uniform heat output in the body of the glasshouse, but supply extra heat around the periphery. The total heat output of a duct is partly by transfer through the duct wall and partly by the discharge of heated air through the perforations. This, then poses the problem of how this battery of perforated ducts is disposed in the greenhouse, as well as the optimum length of the ducts. A duct 60 meters long, used to heat a greenhouse with tomatoes, gave a mean temperature with standard deviation of 0.8°C.

6. An inexpensive greenhouse vent controller. W.J. ROBERTS (USA).

Greenhouses with a plastic film in the United States are usually ventilated mechanically with fans and motor operated louvers. It would be better to control the opening dimensions so that uniform velocity can be maintained. As flow increases with additional fans, the openings or inlets should be increased accordingly. Existing modulating controls used are costly. It is necessary to develop a technique for inexpensive modulable openings for plastic greenhouses. The author proposes a control box 100, allowing four successive positions for the openings, depending on the temperature in the greenhouse.

7. The effect of ventilator opening area on maximal air temperature rise in glasshouses. R.A.J. WHITE (New Zealand).

A comparatice study of ventilators placed on the roof, only with ventilators on the roof and on the side of greenhouse roofs, for the same total ventilation areas and according to the ventilator opening. This interesting approach opens up a new method of study of the efficiency of ventilation in a greenhouse as a function of the wind and solar radiation and merits being taken up for other climates.

8. Air flow and temperature distribution in greenhouses with fan ventilation. J.S. WOLFE and R.F. COTTON (Great Britain).

Air movements are not necessarily uniform but depend on the configuration of the greenhouse and the obstacle in the air: plants, varying height of crop, height-width relation of the greenhouse, etc ... As NISEN points out ;''this study and others show that characteristics of the air (its temperature, the movements which it undergoes, its humidity) are still far from being precisely known in general practice. Some analogies can be drawn from these studies and experiments can be done to see to what extent a desire is pre-determined. Certainly, too many factors come into play simultaneously making it difficult to know how they act upon one another, but nevertheless it remains true that this particular problem is real and merits satisfactory solutions as soon as possible:'

It should be noted that out of 100 % radiant energy, 19 % is immediately reflected by the glass, 12% is absorbed by the glass, and 69 % passes through into the greenhouse. This last percentage is divided in the following way 1 4 % is used for evaporation, 38 % is absorbed by the plant, and 17 % is spread out in the ambient air.

9. Radiation absorption of canopy rows. J.A. STOFFERS (The Netherlands).

This problem is dealt with purely mathematically and by examining short and long wave radiation absorption computed for different geometrical arrangements, different directions of the sun, different directions to diffuse radiation ratios and different amounts reflected on the bottom.

10. Controlled environments for scientific research and horticultural practice. N. de BILDERLING (France)

The complexity of plant reactions to environmental factors. A plant composed of an aerial part and a part underground is submitted to tqo kinds of environments where the constituents can act upon one another, thus providing an infinite number of short duration factors which can modify, more or less profoundly, the sequence of its vital cycle in the present or in the future. Therefore, for leaves as well as for roots, temperature acts in space and in time by its gradient, by its cyclical variation daily and seasonally, etc. Light, which apparently seems to only affect the green parts, must be taken into consideration for such aspects as length, intensity and quality (spectral) which can indirectly affect the mineral nutrition, for example, of a plant. In analyzing the principle reactions one finds at least 56 constituents for aerial parts and 36 for the root environment. It is important to study these diverse environmental factors in specially conceived "environments" (growing spaces), gathered in batteries (phytotrons), alone able to rapidly provide elements of basic understanding of phenomena that can progressively pass into practice.

2nd SESSION. Energy balance and Plant requirements.

Under the presidency of J. DAMAGNEZ (France) this second theme takes up the very special case of energy balance of greenhouses and plants and attempts to link it, whenever possible, to plant needs.

5 papers were presented at this session.

1. Energy balance of an air-inflated polyethylene greenhouse. Mrs E. SLACK and J.A. CLARK (Great Britain).

Comparison of energy balance in an inflated greenhouse with a classic type of greenhouse. If the day temperature are higher in the inflated greenhouse than outside, during the night, quite to the contrary, they become more similar, due to the importance of air volume (8.4 changes of air per hour) needed into greenhouse so that it keeps its form. The inflated greenhouse seems more suited to regions where the hydric balance of plants is unfavorable and limits plants' growth more than the external temperature (too low).

2. Some aspects of energy balance in greenhouses. N. LEVAV and L.G. MORRIS (Israel).

State of the FAO "High Value Crops Project" to perfect a mathematical model, applicable is practice, of thermic and hydric balances in greehouses heated at night by hot water pipes and cooled diurnally by forced ventilation. The Frampton greenhouse is ventilated by air currents of 1.5 m/sec with a cooling system and 25 air renewal per hour. The absorbed energy is spread out in the following way : 21 % for the roof, 26 % for the walls, 22% for the plant and 31 % for the ground.

3. Heat radiation phenomena from a glasshouse crop canopy. M.G. AMSEN (Denmark).

Setting up of a mathematical model to estimate heat exchange between the plant cover and the greehouse. The radiative thermic flux is expressed by a simple equation as a function of optical properties (transmissive and reflective) or physical ones (thermic value and conductivity) of the greenhouse structure. The optical properties have a more important effect than the physical ones.

4. Plant growth optimization using a small computer. T. TAKAKURA (Japan).

Simulation by FORTRAN and SABR programming, point by point, progressing towards optimum by variation of diverse environmental factors. Applying for optimization the maximum CO2 uptake by lettuce in growth chambers.

5. Light-dependent temperature programmes for early-sown tomatoes. A. CALVERT, G. SLACK and R.E. RANDALL (Great Britain).

Most, if not all, November-sown tomato crops in Britain are produced by "Blue-print" method, that is, maintenance of a three-fold CO level and the control constant day and night temperatures at set levels throughout different plant growth stages, irrespective of day to day fluctuations in the light climate. It would be interesting however, to be able to regulate the temperature as a function of light in order to be able to reach an optimal level of photosynthesis at a minimum cost. Description of a new instrument which is noted for its ability to provide a necessary level of CO_2 to the plants by controlling temperature and aeration.

3rd SESSION. Greenhouse and shelter construction.

This third theme taken up under the shared presidency of E.W. LAUBSCHER (South Africa) and J. WHITE (USA) appears to consecrate the official adoption by everyone of plastic material in greenhouse covering. The lectures presented above mainly dealt with fairly new systems (inflatable greenhouses) ; however, research has also been undertaken on more common kinds using various covering materials. This is the reason we have added the term "shelter" to the title of this third session, which was not indicated in the program. Various papers present some ideas on the evolution of the structures of tomorrow.

9 papers were presented at this session.

1. Air-inflated and air-supported greenhouses. W.J. ROBERTS (USA).

A new generation of air-inflated greenhouses stand in opposition to the older air-supported type, in the sense that it is not the greenhouse itself that is inflated but only the plastic shaft, the double wall being able to encircle the frame or to lean on it. This frame as NISEN remarks is sometimes identical to those in classic constructions, and is sometimes reduced to a system of cables which lead to an intermediary type of "bubble house". This type of inflated greenhouse would have many advantages, mainly to maintain the rigidity of the covering, to reduce heating costs and problems arising from condensation. It is easy to assemble. Two persons can cover one acre per day with a two-layer film. The film can last two years.

2. An inflated plastic roof for a multi-span greenhouse. G.E. BOWMAN (Great Britain).

This design makes it possible to reduce heating costs, to compress the loss of light due to supporting structure, often quite low. It would have an easy access and be of simple design. Its very low price gives it a promising future. On the other hand, the second wall would reduce greatly incident insulation and would make the setting up of the construction more complex.

3. A multi-bay inflated house. M.L. BANKS (Great Britain).

The multi-bay inflated greenhouse presents numerous advantages. Study of a plan on 0 Ha of a single house comprising six bays : low profit, easy construction and excellent growth results obtained for spring lettuce, celery, pepper, eggplant, tomato and cucumber.

4. Wind force and greenhouse construction. J.C. SPEK (The Netherlands).

Study of extra force imposed on greenhouses by wind. It is dangerous to want to unduly reduce their values in order to become more competitive. For wind velocity one should consider the means in relation to the length of conservation, either 150 years for greenhouses or only several years for those of plastic. In Holland 42 m/sec is the velocity limit for economic calculations. For plastic ones, it is necessary to consider above all the months from November to April. Discussion of the small structural weaknesses of structures where they are put together.

5. Full-scale glasshouse wind load measurements. D.A. WELLS and R.P. HOMY (United Kingdom).

Wind is the most poorly defined major loads on greenhousps. Important work was done with 48 points for measurements of pressure and comparison with meteorological observations. Description of methods and results. For the South of England wind speed limit-should be 44 m/sec.

6. Type and orientations of glasshouse structures. R.F. HARNETT (Great Britain).

Comparison of multi-span structure from Holland, with a larger Danish greenhouse under English horticultural conditions. In Winter culture the large Danish greenhouse, with an East-West orientation, gives better results than the Dutch greenhouse, but the latter has more advantages in the summer for tomatoes. For lettuce there is a 20 % difference at harvest and 7 days sooner in October-November. Under clear skies the Danish greenhouses with an East-West orientation transmitted more light in winter than the Dutch greenhouses and in the summer the multi-span greenhouses with an East-West orientation receive more light than the same one with a North-South orientation, and than the Danish one. In cloudy weather few differences are observed, no matter what the greenhouse orientation. In conclusion, in the winter maximum light is obtained by orienting the greenhouse in an East-West direction, whereas maximum uniformity of light in the winter as well as in summer is obtained by orienting the greenhouse in a North-South direction.

7. Standardization of designs and equipment. K.C. COKELEY (Guernsey).

A rapid and efficient standardization is desirable not only in design but also in equipment. Work must be undertaken in each country to take into account climatic conditions as well as economic needs. This problem is being studied in Denmark and in Holland but not yet sufficiently in Great Britain.

8. A set of refrigerated greenhouses for crop environment research. L.G. MORRIS and N. LEVAV (Israel).

The plans for these greenhouses and the philosophy of their use for crop research were described in Naaldwijk in 1971. This paper gives information on the progress made in their construction. The ventilators placed in the basement give in a greenhouse of 3 m an ascentional air velocity at plant level of 1 m/sec. These are known as the "cuvette greenhouse" of the FAO project.

9. Root temperature and glasshouse tomato production. A.J. COOPER (Great Britain).

A description of equipment for controlling root temperature in controlled environment cabinets and a project for industrial horticultural installations. Use of black polyethylene with running solution in a closed circuit. The solution is changes four times during the length of tomato or cucumber culture with daily corrections for phosphate and three times weekly corrections for calcium, magnesium, potassium, iron, manganese and boron. The solution is maintained at 25°C, the optimal temperature for tomatoes, but can be modified with a maximal velocity of 3°C in five minutes. Attempts to change the temperature every ten days to a maximum of 30°C gave an increase in weight of the harvest.

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G.D. LOCK*E(U.K.) concluded the symposium by reviewing the evolution of horticulture over the past twenty years, keeping in mind its principle preoccupations : lowering production costs, enlarging nurseries and production plant sizes, changes in technological studies (light transmission, CO., addition, etc.), attempts to automization, working report (comfort and economy), study of plant physiology and finally diverse "stresses" on the plant.

As for us, we would like very much to take up again A. NISEN's concluding remarks which emphasize the interest, the need for and contribution that such meetings are able to make for research as well as for horticultural practice in general : "In conclusion", he said, "we can say that this was an excellent symposium. If, above all, it provides specialists with theoretical information about problems studied, it also offers a favorable outlook for the future the horticulturist can expect practical directives to be suggested to him in the near future by one or another of the many theoreticians who are working on current problems of greenhouses and their climatization. It is valuable for researchers to have an understanding of the problems confronting horticulturists. That they seem resolved to attempt to solve them with the means at hand is better yet. And that a concurrence of views seemed to result from the work done is a definite step towards a solution".

"One should not fear that all this "overly" theoretical work has no usefulness for the practitioner. On **the** contrary, it is indispensible to put into effect the most modern means of investigation since the problems posed are so complex : in certain cases, certain growing practices, deeply rooted, are being ameliorated in order to increase yields and profits. This new practical step forward can only come from a basic knowledge of problems which up until now were not well known".

We would also adopt the general conclusion of NISEN who emphasizes the fact that the Silsoe symposium devoted its time to two new subjects in horticulture :

- That of the computer in research on greenhouse air-conditioning, which comes a long way from those first timid attempts to take up greenhouse problems mathematically.

- That of plastic in horticultural research, with researchers finally accepting it and from now on considering it as a useful agent to which attention must be given.

Finally, we would like once more to take up A. NISEN's exergue in his analysis : "The era of the computer has conquered greenhouse research ... more and more mathematical programs are being set up by researchers who are thereby trying to simultaneously consider all factors which arise in such complex problems as greenhouse construction and environment and which perhaps some clay can "optimize" a phenomenon, using the expression currently in fashion".

"But for us biologists there is a danger for the new-wave research physicists : there is no sense for them to optimize at time **"t"** the climatic conditions of greenhouses or shelters or even growth conditions or plant fruitfulness ... if they lose sight of the fact that a plant presents different requirements in each sequence of its life. Once their partial optimizations are worked out, they must integrate their "primary" results in a new program of optimization which will take into consideration the final plant yield in culture, the only real aim for agronomists. And on this level biologists would once more have a role to play if they seem to have temporarily been pushed into the background by mathematicians. This final output, then, will take into account commercial requirements as well as growth hazards (parasites, predators, ...)".

Note : In conclusion please note that the integral text of reports presented during this symposium will appear in o. coming issue of "Acta Horticulturae" for which copies may now be reserved at the General Secretariat of the I.S.H.S., 1° v.d. Boschstraat 4, The Hague (The Netherlands).

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During the symposoum the participants were able to visit :

1. National Institute of Agricultural Engineering at Silsoe where studies are made of, among other things :

- Fan ventilation of glasshouse
- Wind loading of glasshouse structures
- Inflated roof greenhouses
- The design of ducted-air heating systems
- Reducing glasshouse fuel costs by insulation.

2. Lee Valley Experimental Horticultural Station in Hoddleston (Hertfordshire).

This station edits very interesting annual reports, well documented from a theoretical viewpoint as well as from a practical standpoint, and also such publications as the following :

- Prototypes designed and erected by the Lee Valley Exp. Hort. Stat.
- Film plastic single span greenhouse St. Leaflet N° 17
- Film plastic multi-span greenhouses St. Leaflet N°20
- Cropping in walk-in film plastic tunnels St. Leaflet N° 21

These publications and many others can be ordered by writting to this address : LEE VALLEY Experimental Horticultural Station, Hoddleston, Hertfordshire (United Kingdom).

IV. RESEARCH IN PHYTOTRONICS : A COMPARISON OF PLANT GROWTH IN THE FIELD AND IN THE PHYTCTRON

Received from Professor P.J. KRAMER
Department of Botany, Duke University
DURHAM, N.C. 27706, USA.

In spite of the large amount of research with plant growing in phytotrons few comparisons have been made of plant growth in controlled Environments and in the open. An extensive study was recently started in the Duke and North Carolina State University units of the Southeastern Plant Environment Laboratories (SEPEL) to compare the quantity and quality of growth in growth chambers, air conditioned greenhouses and out-of-doors. This study is financed by a grant from the National Science Foundation. The species being used include cotton, soybeans, tobacco, sorghum, and loblolly pine. Plant4 are being grown in a vermiculite and gravel medium and watered with Hoagland's solution.

Out-of-doors in addition to the potted plants some plants are being grown in field plots.

Measurements are being made of CO2, uptake, transpiration rates, stomatal resistance as measured with a diffusion porometer, and leaf water potential of plants growing in the three environments. Dry weight of roots, stems, and leaves, and leaf areas are being obtained at various stages of growth and final yield of seed in number and weight will be obtained where appropriate. Temperature, vapor pressure deficit of the atmosphere, light intensity, and CO concentration are being measured concurrently with the physiological measurements in all three environments. In many instances measurements are being made from sunrise to sunset or from the time the lights are turned on until they are turned off. It is expected that the environmental and physiological data will aid in explaining any differences in quantity and quality of growth in the three environments. It also should provide data useful in modeling growth of the species under study.

The observations being made in connection with this study already indicate the need for certain improvements in phytotron practice. For example it appears that the CO2 concentration in growth chambers full of large plants cannot be kept at a normal level by the addition of outside air. Constant automatic monitoring and injection of CO2 is essential for maintenance of ambient concentration, which is about 350ppm for SEPEL. Some type of timer-controlled irrigation system also seems desirable because even careful manual watering often results in inadequate and uneven water supply to large plants growing in relatively small containers. Also, mechanical injury frequently occurs when a chamber filled with large plants is hand watered.

In addition to the scientific and operational data, information__ __ is being obtained on the economic efficiency of field and phytotron research. Records are being kept of the time spent on various kinds of experiments from which the economists associated with the project expect to evaluate their relative efficiencies. This information will be useful to administrators who must take decisions concerning the most effective use of research funds. A preliminary example of this approach is presented in a paper by Dr RAPER, my collaborator in this project.

Phytotronic Newsletter Editors' Notes :

We believe that the report presented by Professor P.J. KRAMER is particularly pertinent and opportune, given the difficulties facing research in all countries in the world. We would like to propose that in each issue several pages be devoted to similar remarks and diverse orientations which could advance and improve our techniques and research means. So, we ask all of you to kindly send us documents immediately, which we will print in the briefest delay possible.

P. CHOUARD and N. de BILDERLING

V. RICE PHYSIOLOGY

Received from Dr B.S. VERGARA
Plant Physiologist
Rice Research Institute (IRRI)
P.O. Box 583, MANILA, Philippines

I. Abstract.

The need for a phytotron at IRRI is best summed up by the report of Dr Lloyd EVANS from Australia. "The achievements of IRRI to date have not required really new scientific analysis and techniques... From now on, however, further increases in yield will be more difficult to achieve ... Thus, further green revolutions must be more modest in their gains and will be won only with much more insight into the physiological basis of crop production on the one hand and into the epidemiology of rice pests and diseases on the other. Ready access to a phytotron could play a crucial role in both these programmes".

Lines developed at IRRI provide future rice varieties not only for the Philippines but for many tropical countries. Varieties with wider adaptability are therefore necessary. Although insensitivity to photoperiod has already been attained in the new lines, enabling them to flower even under long day-length conditions, insensitivity to temperature has not been considered in earlier years. The spread of IRRI varieties to subtropical areas have resulted in unfavorable responses which were not apparent under tropical conditions.

A look at the temperature pattern in different rice growing areas during the growing season shows that there is a variety of possible temperature problems. Unfortunately, virtually, nothing is known about the reaction to temperature of indica varieties. Researches on these problems are imperative in order to increase the adaptability, the potential and actual yield of rice in the tropics.

This paper discusses the problems of rice physiology associated with temperatures and the need for studies under controlled conditions.

II. Problems to which phytotrons can make useful contributions.

Detailed studies in the laboratory and in the field of IRS, a tropical rice variety, and its planting in different parts of the world has given the physiologists and ecologists a basic plant whose growth and morphological changes can be compared. Naturally, comparison of growth responses of IR8 under field conditions is subject to many biases and possible errors. Nevertheless, one can determine if there is any abnormality in the growth of IR8 in a certain place by comparing it with the growth in our Institute although one may not be able to pinpoint the cause of such abnormality.

In many instances, the environmental factor that seems to influence the particular response is temperature. Unfortunately, little is known of the response of indica varieties to temperature and facilities are not available for such studies.

In the introduction of improved varieties like IR8 and in their use as parent materials in producing new varieties, a knowledge of their response to temperature is of utmost importance.

Temperature problems differ from one area to another. In northern latitudes rice plants are sown at a low temperature which increases up to flowering time and then decreases, as in Hokkaido (Japan) (Fig. 1). In Hokkaido, low temperature is a problem to sowing and sometimes at flowering. Low temperature during sowing is also a problem on Bangladesh, California and Arkansas (USA), Nepal, Korea, Australia, India and Iran.

At sowing time areas in the lower latitudes, like Los Banos, Philippines, have a high temperature which slowly declines until maturity. The temperature, however, is within safe limits and is not a problem in rice growing. Temperature changes least in areas near the equator.

In high altitude areas in the tropics, like La Trinidad, Philippines (1,310 m elevation), the temperature is almost uniformly low throughout the growing season. The temperature pattern is very different from that in the high 141itude areas. For example, the temperature during panicle emergence at La Trinidad is lower than that at Hokkaido, the northernmost area planted to rice in Japan. High temperature during panicle initiation to flowering stage is possible, however, even at high altitudes, as in Kathmandu, Nepal.

Perhaps the biggest problem of low and of high temperatures during the rice cropping season is found in the northern part of India, Bangladesh and Pakistan where there are several cropping seasons. Low temperature during the sowing stage is the problem during the Boro (November-May) crop season, while low temperature during flowering to harvest is the problem in the Aman season (July-November). During the Aus season (March-August), high temperature, especially at flowering time, can be a problem.

Optimum temperatures for germination, seedling growth, tillering, panicle initiation and development, anther dehiscence, and ripening have been determined by a number of workers. These optimum temperatures, however, might vary with the variety. Also, having the optimum temperature for certain growth phases of the rice plant probably is not necessary for obtaining high grain yields. In many cases, optimum values are determined on the basis of maximum vegetative growth rather than on direct relevance to grain yield. The following are some temperature problems that may be resolved with the use of phytotrons :

Spikelet formation. The number of spikelets/sq m is usually a limiting factor in grain yields. In the tropics, if one tries to increase the panicle number/sq m, the spikelet/panicle decreases so that the total spikele0q m remains more or less the same. IR8 at the Institute's farm have around 100 spikelets/panicle and around 200 panicles/sq m. If the panicle number/sq m is increased to 600, the spikelet/panicle decreases to 60. In Australia, however, the increase in panicle number does not decrease the spikelet number. This is one reason why they have high yields of IR8 there. The minimum temperature during panicle initiation is much lower in Australia. What effect has temperature on the development of the panicle 7 Does it slow down the development resulting in less aborted or degenerated spikelets 7 If so, can we apply a treatment to delay development ? How important is the rate of photosynthesis during this period ?

Anthesis and sterility. High sterility of IR8 planted in subtropical regions is one of the most serious temperature problems. Low temperature

(15 to 17 C) has been reported to increase sterility and inhibit anthesis. Below 21 C, no anthesis occurs in IR8. How long can IR8 remain at 21 C during heading and still have viable pollen or receptive stigma when the temperature rises ? At La Trinidad, Philippines, the temperature during the day may remain below 21 C for several days. Usually the rice plants here have very high sterility.

Some experiments have been performed on the anthesis of IR8 using growth chambers. The temperature range, however, is limited so that the maximum temperature at which anthesis could occur could not be determined. In Pakistan, the temperature at anthesis may reach 42 C. What effect does it have on sterility and grain weight ? Are there varieties resistant to high temperature at anthesis ? What is the physiological basis of tolerance to high temperature at this stage ? Unless we know these, there is little we can do in advising the farmers regarding the high sterility in their rice crops. We can infer that it is temperature and suggest a planting date wherein flowering will occur at lower temperatures.

- Ripening period and the shattering, domancy and germination of seeds. Rice varieties show different dormancy period and ability to germinate at low temperature. A rice variety harvested during the monsoon has high dormancy, thus preventing the germination of seeds while still in the field even if it rains continuously for several days. The same variety has no or little dormancy when harvested during the dry season. An occasional rain during the dry season might destroy a ripening crop. How does temperature during ripening affect the dormancy of the seeds ?

Preliminary data show that seeds harvested at certain months of the year have greater ability to germinate at low temperatures.

The percent shattering of seeds are higher during the dry season than the wet season.

The effect of nutrition during ripening on the shattering, dormancy and germination of the seeds have been studied but no correlation has been found. The factor that seems critical is temperature. Growth under controlled temperature conditions during ripening is needed to be able to clear this matter.

- Tolerance to low temperature at seedling stage. Low temperature at seedling stage is a problem in Japan, Korea, California, USA, Bangladesh, North Territory Australia and other countries. The problems are, however, slightly different from one country to another. In Japan, the temperature is low both day and night and the diurnal fluctuation is relatively large. Seedlings are artificially protected, however the susceptible seedlings may still develop yellowing. In Australia, the minimum temperature is low but 10 C higher than in Hokkaido, Japan, while the maximum temperature is very high (32 C) ; consequently the diurnal change is also large. Under such conditions, browning or desiccation occurs - no yellowing.

In California, pre-germinated rice seeds are sown directly in fields with 5 to more than 10 cm of cold water. Here the problem of low temperature is different. In any case, yellowing can occur during seedling or transplanting stage. What critical temperatures are involved in such a yellowing ? In Browning ? What happens during yellowing?

In studying the low temperature problem at seedling stage, a phytotron with as many different possible temperature combinations is needed to cover the whole range encountered under natural conditions.

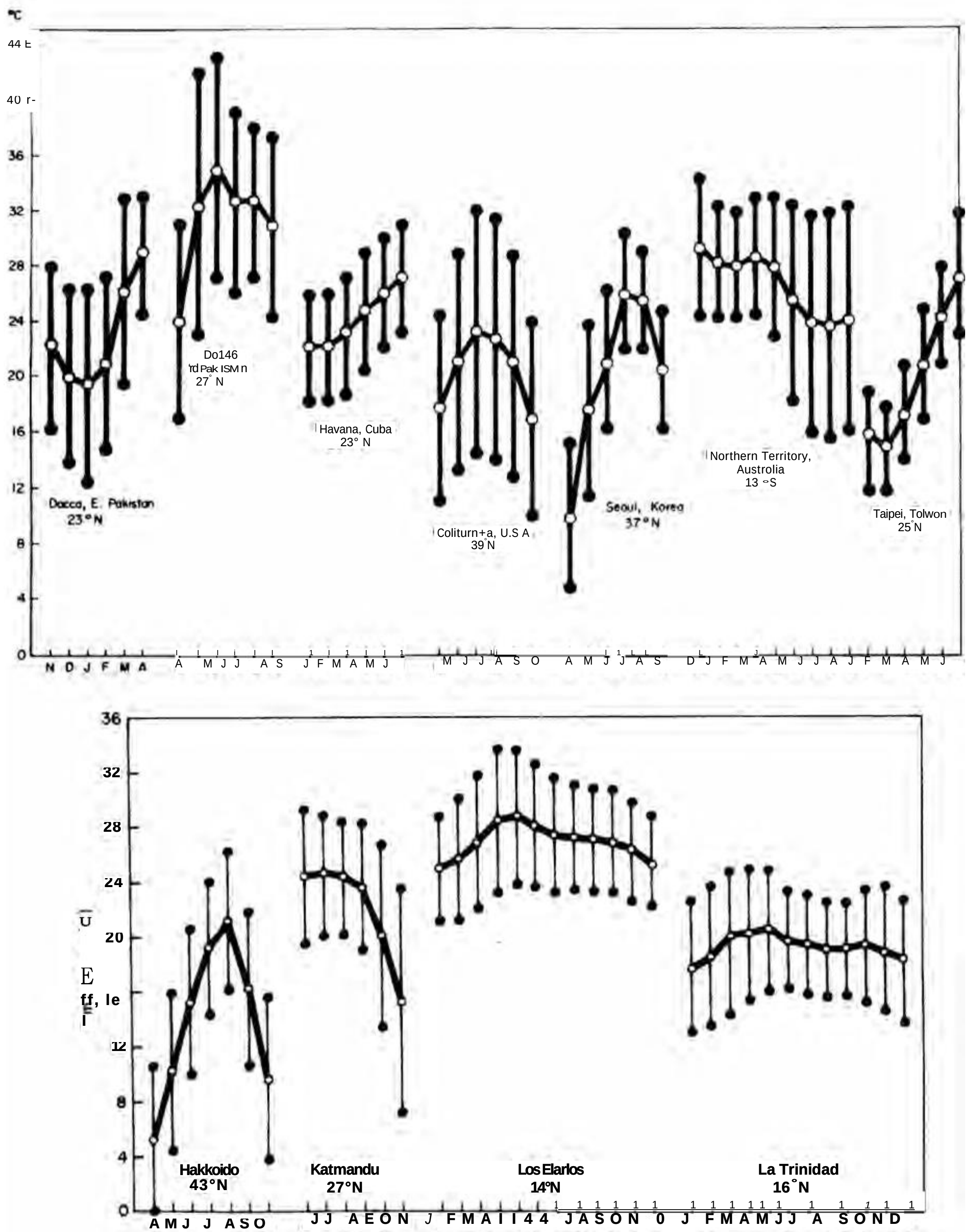

Figure 1a and 1B. Temperature patterns during the cropping season at different rice growing areas.

Protein content. Research on increasing the protein content of the rice grain has been going on for the last four years at the Institute. We know that higher levels **of** nitrogen fertilizer, late application of nitrogen fertilizer, uider spacing and early maturing varieties contribute to higher protein content of the grains. However, there is very little known on the effect of climatic factors. We know that the protein content varies with the date of harvest and within a plant there is a wide range of variability.

These are some of the obvious problems at present. Minor temperature problems such as internode elongation, non-exertion of the panicle, development of leaves, prolongation of the basic vegetative phase, photoperiod sensitive phase and flowering phase, and development of white tip need to be studied also.

Perhaps one of the most important problems that can be solved by the phytotron is the ecology of the insect populations. The insects are still the number one limiting factor in rice production in Asia, especially now that improved plant types have been developed.

Perhaps the experts here can make suggestions on the approaches to some of the problems I have listed - better still, they may want to pick up the problems and work on them. We have enough field problems of our own and would be glad if some other scientists would take up these basic problems.

Editors* Note : The text of this paper on Rice Physiology which was sent in March 1974 is nearly the same as the lecture presented at the symposium at Duke University in May 1972. Since then the IRRI inaugurated its Phytotron in September 1974 and we believe that some of the problems which have been brought up are already being studied. We hope and would like the IRRI Phytotron to send us its program of research and would be happy to print it for our readers' Of course, the same welcome will be given to any other reports which we receive from other Phytotrons.

P. CHCUARD and N. de BILDERLING

VI. PHYTOTRONICS AT THE XIITH INTERNATIONAL **INOTASICAL** CONGRESS IN LENINGRAD (July 1975)

PROJECT FOR A ROUND TABLE DISCUSSION: REQUIREMENTS AND USES OF PHYTOTRONS

Many readers have asked us to open up our Bulletin for communicating exchanges of views or for preparing the programs for important meetings. As a result, we thought it worthwhile to immediately profit from the Botanical Congress in Leningrad (July 1975) to test a formula for the preparation of an international meeting. It seems even more worthwhile to us, to do so, as the time left is very short.

At the Botanical Congress, as was done at the Horticultural Congress in Warsaw, all speeches and papers are limited to ten minutes in length. This short time limit hardly allows for a short summary, often dry, without any possibility for discussion or even comments on the results or new ideas which have been put forward.

On the other hand during this same Congress in Leningrad, *the* organization of "unplanned" round table groups are being planned, and the use of bulletin boards for comments, discussions of results or exchanges of opinions.

Based on the above and without waiting any longer, we propose to our readers the organization of a round table on a theme which was often discussed during the meeting held in London in 1964 with the assistance of UNESCO, of which the minutes were published by the CNRS (Title "Phytotronique", edited in 1969 by the CNRS, 15, Quai Anatole France, 75700 Paris).

The subject of this round table discussion would be :

"REQUIREMENTS. USES AND COSTS OF PHYTOTRONS"

Given the world wide monetary problems which heavily affect research in general and biology in particular, we thought that some of the following tables might serve as an introduction to this discussion.

These tables were drawn up after an investigation carried out by the "Secretariat Phytotronique" since 1968 at principal centers. All the figures do not take r account salaries and were based on the value of 1967 US dollar. Certain Phytotrons or Centers which have not answered our questionnaire, could send us the missing complementary information that we will of course print.

Thank you in advance.

We kindly request that our readers communicate to us their desire to possibly participate in the round table discussion, indicating a summarized theme and the length of time which should be reserved for their intervention, so as to foresee a plan of organization and the global duration of this meeting, discussions included.

Before the Conference, either in the next issue of the Phytotronic Newsletter (N° 10), or by writing directly to the various participants who have contacted us, we plan to communicate the results of this consultation and the measures taken.

Of course, if the participants think of other subjects for round table discussion, we ask them to send them to us, supported by explanations that we *will* diffuse, possibly foreseeing other meetings.

If this Phytotronic Panel Discussion in Leningrad is a success (and eventually ethers) we plan to include it in the coming book "Phytotronics". This volume, with the authorization of the XIIth International Botanical Congress organizers, will contain the minutes of Symposium N° 6 (Phytotronics) of Section 10 (Growth and Development).

We will inform our readers in due time of the publication of this volume.

Table 1. Phytotrons and biotrons in activity in 1974

Year of opening	Name - City - Country	Space usable for plants m²	Number of conditioned units: Natural light greenhouse	Artificial light: Room	Artificial light: Cabinets: Walk in	Artificial light: Cabinets: Reach in	Température °C: Min.	Température °C: Max.	Température °C: Précision	Relative humidity % RH: Amplitude	Relative humidity % RH: Précision	Wind velocity m/sec	CO_2 control	Maximum artificial light intensity
1950	Phytotron, Liege, Belgium	40	1	6	-	-	+12	+40	± 0,5	60 - 90	± 2,5	0,5	-	15 000 lux
1954	U.R.S. Ottawa, Canada	339	4	21	10	35	- 5	+35	± 0,25	60 - 90	± 3	0,35-0,61	300-2 000 ppm	43 000 "
1955	Bayer Leverkusen, Germany - F.R.G.	16	-	-	4	-	- 5	+35	± 1	40 - 95	± 5	-	-	10 000 "
1956	Phytotron I, Fukuoka, Kyushu, Japan	132	6	5	-	-	+10	+35	± 1	60	± 5	1-30	-	30 000 "
1957	Ostankino, Moscow, USSR	440	4	-	19	12	-60	+45	-	20 - 90	-	0-4,8	-	55 000 ergs/cm²/sec
1959	Bayer, Leverkusen, Germany - F.R.G.	336	19	-	-	-	+15	+35	± 1	40 - 95	± 5	0,1	-	8 000 lux
1959	University of Florence, Italy	53	2	2	-	-	- 2	+35	± 1	40 - 90	-	-	-	-
1961	Rauisch, Holzhausen, Germany - F.R.G.	136	4	8	8	-	+ 2	+40	± 0,5	50 - 95	± 5	0,2 -4	0,03-3vol %	0 - 30 000 "
1962	CSIRO, Canberra, Australia	506	15	-	-	38	+ 3	+50	± 0,5	10 -100	± 2,5	0,6	-	15,28 cal/cm²/Hr
1962	David, North, Australia	253	5	8	-	-	0	+45	± 0,3	-	-	-	-	-
1963	IRSIA, Gembloux, Belgium	64	-	2	-	-	- 5	+30	± 0,5	40 - 95	± 2,5	-	-	18 000 lux
1963	CNRS, Gif s/ Yvette, France	604	8	12	-	15	-10	+50	± 0,3	10 - 99	± 5	0,2	-	120 000 ergs/cm²/sec.
1963	Horticulture, Wageningen, Netherlands	294	8	6	-	-	+ 9	+24	± 1	70 - 80	-	0,6	-	17 000 lux
1963	Fruit Station, Hiratsuka, Japan	235	6	4	-	-	+ 8	+35	± 1	70	± 5	0,3 -10	-	25 000 "
1965	Stockholm, Sweden	195	2	7	-	-	+ 5	+40	± 0,2	70 - 95	-	-	-	22 000 "
196.	Hitsujigaoka, Sapporo, Japan	158	7	3	1	6	+ 8	+35	± 1	70 - 85	± 5	0,1 -0,3	-	0,442 g/cal/cm²/m
1967	Biotron, Madison USA (only plant)	252	-	20	-	-	+10	+35	-	20 - 95	-	-	-	-
1967	Kyushu Biotron, Japan (" ".)	155	9	1	2	8	- 5	+40	± 0,5	60 - 70	± 5	0,3 -0,5	100-1 000 ppm	50 000 lux
1968	Freiburg I Br. Germany - F.R.G.	260	7	12	-	-	+ 2	+40	± 1	50 - 95	± 5	-	0,03-3 vol %	0 - 40 000 "
1968	Guelph, Canada	-	-	11	18	25	- 1	+35	-	55 - 70	-	-	-	20 000 "
1968	Tobacco Station, Hatano, Japan	125	4	3	-	-	+11	+35	± 0,5	60 - 85	± 3	-	200-2 000 ppm	30 000 "
1968	Duke University, Durham, USA	409	6	10	10	27	0	+45	± 1	35 - 95	-	-	-	0,28 g cal/cm²/m
1968	N.C. State University, Raleigh, USA	400	3	22	10	20	- 7	+48	± 0,5	65	± 3	-	-	48 000 "
1969	Freising Weihenstephan, Germany-F.R.G.	-	7	3	-	-	+12	+35	± 0,5	50 - 90	± 5	0,2	-	400 W/m²
1969	DSIR, Palmerston North, New Zeland	182	-	24	-	-	-15	+50	± 0,3	10 - 95	± 3	0,3 -0,5	50-1 000 ppm	200 à 450 W/m² PAR
1970	Irkoutsk, USSR	432	6	-	21	-	-20	+50	± 0,25	15 - 95	± 2,5	0,3	0,5 - 2 vol %	20 000 lux
1970	Tech. Univ. Hannover, Germany - F.R.G.	36	-	-	9	-	+13	+40	± 0,2	40 - 95	± 3	0,2	400-10 000 ppm	30 000 "
1970	Botanical, Szeged, Hungary	16	-	4	-	-	+10	+30	± 0,5	45 - 90	± 3	0,5 -10	0,03 %	22 000 "
1972	Liege University, Belgium	76	-	10	2	-	+ 2	+45	± 0,3	15 - 95	± 2	0,3	-	50 000 "
1972	Martonvasar, Hungary	136	-	14	14	16	-20	+40	± 0,5	50 - 90	± 3	0,2 -0,8	-	100 000 "
1972	Krakow, Poland	185	8	7	-	4	+ 5	+45	± 0,5	20 - 90	+ 5	-	0,03 - 0,5 %	15 000 "

TABLE 2. <u>Construction costs of different Phytotrons</u>

Name - City - Country	Year of construction	Usable space for plants sq. m.	Total costs in currency	Total costs in US dollars	Price in $ per usable space sq. m.	% consumer price base 1967	Price in $ (1967) per usable space sq. m.
Pasadena, Earhart, USA	1949	392	-	407 000	1 038	71,4	741
Phytotron, Liège, Belgium	1950	40	3 M. F.B.	60 000	1 500	72,1	1 081
ORS, Ottawa, Canada Greenhouse	1954	194	253 000 $ C.	253 000	1 304	80,5	1 050
University of Florence, Italy	1957	53	35 M. Lires	56 000	1 057	84,3	891
Rauisch Holzhausen, F.R.G.	1958	40	1,2 M. D.M.	320 000	8 000	86,6	6 928
Phytotron I, Fukuoka, Japan	1959	132	32,8 M. yens	88 750	672	87,3	587
CSIRO, Canberra, Australia	1962	506	1,364 M. $ A.	2 018 720	3 989	90,6	3 614
IRSIA, Gembloux, Belgium	1963	64	3,4 M. F.B.	68 000	1 062	91,7	974
Horticulture, Wageningen, Netherlands	1963	294	1,9 M. Fl.	570 000	1 939	91,7	1 778
Fruit Station, Hiratsuka, Japan	1963	235	110 M. yens	306 000	1 302	91,7	1 194
Biotron, Madison, USA	1964	544	-	4 813 351	8 848	92,9	8 220
Stockholm, Sweden	1965	195	4,5 M. Sw.Kr	900 000	4 615	94,5	4 361
Hitsujigaoka, Sapporo, Japan	1966	158	143 M. yens	476 000	3 013	97,2	2 929
Kyushu Biotron, Japan	1967	156	175 M. yens	486 000	3 115	100	3 115
O.R.S. Ottawa, Canada Phytotron	1967	145	1 146 503 $ C.	1 146 503	7 907	100	7 907
CNRS Gif s/ Yvette, France, total	1968 Est.	604	18 601 384 F.F.	3 720 300	6 159	104,2	6 418
CNRS " " supergreenhouse	1968 "	1 026	7 114 800 F.F.	1 422 960	1 387	104,2	1 445
Duke University, Durham, USA	1968	409	-	1 896 100	4 623	104,2	4 817
N.C. State University, Raleigh, USA	1968	400	-	2 485 500	6 214	104,2	6 475
DSIR, Palmerston North, New Zealand	1969	182	890 000 $ N.Z.	988 000	5 429	109,8	5 961
Irkoutsk, USSR	1969	432	700 000 R.	700 000	1 620	109,8	1 779
Taïwan Phytotron	1969	874	-	6 739 807	7 711	109,8	8 467
Tech. Univ. Hannover, F.R.G.	1970	16	245 800 D.M.	82 000	5 125	116,3	5 960
Botanical Szeged, Hungary	1970	16	1 M. Fts	43 000	2 700	116,3	3 140
Krakow, Poland	1971	185	42 M.Zlotty	700 000	3 780	121,3	4 585
Liège University Room, Belgium	1972	70	14 M.F.B.	400 000	5 714	125,3	7 160
" " W.I. Cabinet, Belgium	1972	6	2 M. F.B.	50 000	8 333	125,3	10 441
Martonvasar, Hungary	1972	136	25,6 M. Fts	513 525	3 776	125,3	4 731
Biotron Center Japan Project, total	1972 Est.	1 104	-	7 715 156	6 988	125,3	8 756
" " " Art. Light room	1972 "	400	-	3 092 500	7 731	125,3	9 687
" " " Greenhouse	1972 "	128	-	450 000	3 516	125,3	4 405
" " " super greenhouse	1972 "	576	-	444 375	771	125,3	966

TABLE 3. Allotment of construction costs of different Phytotrons (in percentage of total)

Name - City - Country	Building	Plumbing	Heating conditioning	Electrical	Growth chambers	Movable equipment	Other fees and honorary
Rauisch Holzhausen, F.R.G.	23,5	7,0	18,7	2,8	41,5	4,5	2,0
CSIRO, Canberra, Australia	29,0	11,0	1,5	5,0	33,0	1,5	19,0
IRSIA, Gembloux, Belgium	29,4	4,2	47,0	14,0	-	4,7	0,7
CNRS, Gif s/ Yvette, France	23,5	6,0	50,9	13,0	-	2,7	3,9
" " Super greenhouse	53,1	6,1	22,3	6,3	-	8,4	3,8
Fruit Station, Hiratsuka, Japan	30,9	5,3	44,1	19,7	-	-	-
Stockholm, Sweden	30,6	-	14,8	23,8	18,4	7,3	5,1
Duke University, Durham, USA	29,9	6,9	19,5	7,5	22,4	4,2	9,6
N.C. State University, Raleigh, USA	27,8	5,8	17,5	8,1	28,0	4,0	8,8
DSIR, Palmerston North, New Zealand	42,4	3,6	8,9	13,0	18,9	6,0	7,2
Tech. Univ., Hannover, F.R.G.	1,6	0,4	-	5,0	91,0	1,8	0,2
Botanical Szeged, Hungary	50,0	6,0	20,0	5,0	10,0	7,0	2,0
Martonvasar, Hungary	33,0	4,0	5,0	12,5	25,0	8,0	12,5
Krakow, Poland	28,0	6,5	20,0	7,5	3,5	31,5	3,0
Mean for all (4 014 sq. m.)	30,9	5,2	20,7	10,2	20,8	6,6	5,6

TABLE 4. Running costs of different Phytotrons

Name - City - Country	Examining year	Usable space for plants sq. m.	Total costs in currency per year	Total costs in U.S. $ per year	Price in $ per usable space per year	% consumer price base 1967	Price in $ (1967) per usable space per year
Phytotron, Liège, Belgium	1968	40	765 000 F.B.	15 300	382	104,2	398
O.R.S. Ottawa, Canada	1973	339	179 456 $ C.	179 456	529	133,5	706
Phytotron I, Fukuoka, Japan	1972	132	10 M. yens	35 700	270	125,3	338
University of Florence, Italy	1964	53	6 095 680 lira	9 756	184	92,9	171
Rauisch Holzhausen, F.R.G.	1972	136	200 000 D.M.	85 000	625	125,3	783
CSIRO, Canberra, Australia	1969	506	92 130 A $	136 352	269	109,8	295
David, North Australia	1969	253	35 439 A $	52 449	207	109,8	227
IRSIA, Gembloux, Belgium	1971	64	800 000 F.B.	16 000	250	121,3	303
CNRS, Gif-sur-Yvette, France	1968-72	604	896 000 F.F.	179 000	296	116,0	343
Fruit Sta., Hiratsuka, Japan	1972	235	9 460 000 yens	26 300	112	125,3	140
Stockholm, Sweden	1972	195	332 000 S.K.	66 400	340	125,3	426
Hitsujigaoka, Sapporo, Japan	1970	158	9 400 000 yens	31 000	196	116,3	228
Kyushu Biotron, Japan	1972	113	14 400 000 "	51 400	455	125,3	570
Kyushu Reach in Growth Cabinet, Japan	1972	16	3 500 000 "	12 500	781	125,3	978
Kyushy Greenhouse, Japan	1972	176	2 100 000 "	7 500	43	125,3	54
Duke University, Durham, USA	1972-73	409		55 990	137	129,4	177
DSIR, Palmerston North, N. Zealand	1973	182	72 550 $ N.Z.	80 530	443	133,5	591
Irkoutsk, U.S.S.R.	1969	432	95 000 R.	95 000	220	109,8	241
Tech. Univ., Hannover, F.R.G.	1972	16	87 000 D.M.	2 900	180	125,3	226
Botanical Szeged, Hungary	1972	16	80 000 Ft.	1 800	112	125,3	140
Martonvasar, Hungary	1973	136	3 650 000 Ft.	73 000	537	133,5	717
Krakow, Poland	1972	185	3 M. zlotty	50 000	270	125,3	338

TABLE 5. Allotment of running costs of different Phytotrons (in percentage of total)

Name - City - Country	Maintenance	Heating	Water	Electricity	Materials and Chemicals	Lamps	Examining year
Phytotron, Liège, Belgium	14,0	11,0	8,0	56,0	6,0	5,0	1968
Phytotron I, Fukuoka, Japan	22,0	16,0	1,0	61,0	-	-	1972
University of Florence, Italy	8,0	-	-	87,0	-	5,0	1964
Rauisch Holzhausen, F.R.G.	70,0	6,0	-	20,0	1,5	2,5	1972
CSIRO, Canberra, Australia	31,0	-	0,1	56,4	9,2	3,3	1969
David, North, Australia	27,1	4,5	2,7	62,7	3,0	-	1969
IRSIA, Gembloux, Belgium	31,3	25,0	1,9	37,5	2,5	1,9	1971
Fruit Sta., Hiratsuka, Japan	13,4	12,4	1,9	66,9	5,4	-	1972
Hitsujigaoku, Sapporo, Japan	25,0	9,2	1,5	51,2	-	13,1	1970
Kyushu Biotron, Japan	29,0	16,0	4,0	51,0	-	-	1972
Duke University, USA	15,2	8,1	2,3	53,6	13,8	6,8	1972-73
D.S.I.R. Palmerston North, New Zealand	28,2	5,0	3,9	39,7	9,9	13,2	1973
Irkoutsk, USSR	-	-	19,0	58,0	23,0	-	1969
Tech. Univ., Hannover, F.R.G.	5,7	-	1,8	83,6	4,3	4,6	1972
Botanical Szeged, Hungary	12,0	25,0	5,0	40,0	9,0	10,0	1972
Martonvasar, Hungary	7,0	5,0	2,0	69,0	5,0	12,0	1973
Krakow, Poland	26,7	12,6	0,2	29,8	26,7	4,0	1972
Mean for all (3 690 sq. m.)	21,5	9,2	3,2	54,3	7,0	4,8	-
ORS, Ottawa, Canada	23,1	←	70,2	→	1,4	5,3	1973
Stockholm, Sweden	33,8	←	51,2	→	9,0	6,0	1972
CNRS, Gif s/ Yvette, phytotron greenhouse	21,0	26,4	2,5	46,2	3,9	-	1968-72
CNRS " phytotron art. light room	19,1	18,5	3,1	52,8	1,4	5,2	"
CNRS " super greenhouse	9,7	40,5	7,4	37,2	5,2	-	"
CNRS " reach in cab. 80 W Fl. lamps	47,3	-	-	42,6	4,3	5,8	1972
CNRS " " " 215 "	19,0	-	-	76,2	1,9	2,9	"
CNRS " " " Xenon lamps	18,9	-	-	62,1	1,7	17,3	"
Kyushu Biotron Growth Cabinet, Japan	51,0	-	1,0	48,0	-	-	1972
Kyushu Biotron Greenhouse, Japan	24,0	44,0	7,0	25,0	-	-	1972

Table 6. Cost in dollars (1967) of expenses for controlled environments.

Kind of environment		Construction price: Price differences $/m²	Construction price: Corresponding surface (m²)	Construction price: Average $/m²	Annual maintenance expenses (salaries excluded): Price differences $/m²	Annual maintenance expenses (salaries excluded): Corresponding surface (m²)	Annual maintenance expenses (salaries excluded): Average $/m²
Super greenhouses or air-conditioned greenhouses		600 to 1 500	1 968	1 201	50 to 165	1 374	174
phyto-trons	average	1 000 to 8 000	5 461	4 934	140 to 780	3 618	339
phyto-trons	greenhouses only	1 000 to 7 000	432	5 525	140 to 570	304	298
phyto-trons	rooms with artificial lighting	2 000 to 8 000	1 873	7 466	300 to 780	714	486
In France (Gif-sur-Yvette)							
Artificially lit rooms	: 80 W fluo lamps			6 862	-	-	391
" lit cabinets	: 80 W fluo lamps			6 700	-	-	578
" " "	:215 W fluo lamps			8 000	-	-	719
" " "	: Xenon lamps 2 x 6 KW			12 000	-	-	1 450

VII. COMMERCIAL APPLICATION OF SODIUM LIGHTING FOR PLANT GROWTH IN THE UNITED KINGDOM

Received from Dr. J.A.C WEIR
Agricultural Section
The Electricity Council, 30 Millbank
London SW1P 4RD U.K.

Only comparatively recently have the sodium-discharge lamps (low-pressure and high pressure) become generally accepted for use in commercial horticulture. Apparent adverse spectral characteristics and relative initial high cost have been the chief factors acting against their use and thus favoring mercury-discharge lamps. Successful trials, increase in rated lamp life and the design of effective reflectors for horticultural use have all helped to reverse this trend resulting in the successful establishment of the 180 w low-pressure sodium

* Complete purpose-made fittings (luminairs) are available from specialist suppliers in the U.K.

(SOX) and 400 W high-pressure sodium (SON/T) lamps for supplementing daylight in commercial horticulture.

In the U.K. both high and low-pressure sodium lamps are gaining in popularity for the production of tomato and cucumber plants. Although both types of lamp are also generally effective for the supplementary lighting of lettuce some varieties have shown certain undesirable growth responses (excessive petiole elongation and longitudinal rolling of leaves) particularly with low-pressure sodium lamps under poor natural light conditions. These defects do disappear, however, when the plants are grown under natural light. It is important, however, when using lighting to select varieties of lettuce which are known to be amenable to sodium lighting. In recent trials both high and low-pressure sodium lamps have been found effective for the supplementary lighting of year-round (YR) chrysanthemums during the poor-light winter months. Low-pressure sodium lamps have also been used, with considerable success, in speeding up the growth rate of Sitka spruce seedlings for research purposes; growth response has been such that there may well be a commercial justification for using lighting in this role.

In Britain the 180 W SOX and 400 W SON/T lamps, both with purpose-made reflectors are normally used for horticultural lighting. Apart from their spectral differences the physical characters of both types of lamp have to be taken into account. The SOX lamp is decidedly "linear" in form and the SON/T lamp can be regarded as a "point" source. This fact must be borne in mind when designing a plant lighting scheme. Similarly, account must also be taken of the differing relationship *between* illuminance and irradiance for the two types of lamp. Guidance on both these aspects of lighting design can be found in Grow-Electric Handbook N° 2 (Lighting in Greenhouses), a publication issued by the Electricity Council, 3D Millbank, London SW1P 4RD.

Although both types of lamp can be used successfully in single rows over narrow benches their illuminating effect is only really maximised if they are arranged in "block" layouts, thus reducing "edge effect". It is in large "block" schemes that both the sodium lamps really come into their own with the high-pressure sodium lamps having, by a narrow margin, the lowest overall cost per unit of lit area. Recent forecasts of improvements in efficiency of the high-pressure sodium lamp mean that in the near future it will be even better placed in comparative economic terms.

Perhaps the most important factor operating in favour of the sodium lamps is the effect of rising energy costs. Their higher operating efficiency means that the running costs component, as a proportion of their total cost, is lower than that of the mercury lamps and, thus, any increase in the cost of electricity has a proportionately greater effect on the total cost of a mercury lamp system. With this fact in mind, lamp manufacturers are now marketing 360 W, 330 W and 310 W high-pressure sodium lamps as "plug-in" replacements for 400 W mercury-fluorescent lamps which will operate on the existing control gear giving substantially more light at a lower electrical ,loading than the lamps they replace. These replacement sodium lamps, designed for visual illumination such as street lighting, are, by good fortune, highly suitable for horticultural purposes offering even further economies in lighting for plant production.

VIII. NEWS OF INTEREST FOR PHYTOTRONISTS

a) Phytotronics at the XIXth International Horticultural Congress in Warsaw (Poland) September 1974.

It was during the course of this Congress that the word "phytotronics" appeared for the first time in the list of subdivisions officially foreseen by the organizers, and there is every reason to believe that environment control for plants will henceforth form an autonomous section in future conferences.

This remarkable Congress which brought together more than 5 000 participants was organized in a masterly manner and everyone was very satisfied with the general atmosphere, the facilities offered, the meetings and of course the exchanges of ideas and of knowledge.

It is hoped that the organizers of this Congress will read in these few lines the thanks on the part of the Secretariat Phytotronique, who were able to benefit from all the help needed, and efficient help at that!! This help made is possible, although unfortunately for only 15 privileged people,
(due to the late date of announcement and the relatively high cost) to visit the Phytotron in Cracow and to speak with the researchers working there.

The three working afternoons of Session N° 25 entitled "Phytotrons in horticultural research" made it possible for participants to hear about 20 papers with some debates and discussions. But, in reality, phytotronics did not end there. As a matter of fact, it was quickly apparent that two working meetings of Session N° 42 : "Climates in protected spaces" on the one hand, and that of Session 54 : "Glass and plastic greenhouses, their equipment and arrangement" on the other hand, can be included under the name of "Phytotronics".

We therefore asked the organizers of the Congress as well as those officers of the International Society of Horticultural Science to kindly unite the varied lectures from all of these three sessions in one single book : "Phytotronics 3". The authorization was given to us. Thus, the Congress over, the Secretariat Phytotronique is preparing an edition of this book where about 50 lectures will be gathered which were presented in Warsaw and whose subjects might interest our readers and aid in setting up a small specialized library.

We hope that the work will be off the presses around June-July 1975.

Persons who desire to have it can here and now send their requests for information to Editions Gauthier-Villars-Bordas, 24-26 Boulevard de l'Hopital 75005, Paris.

b) New books

- Actes du premier Colloque Informatique et biosphere, Paris. Informatique et biosphere, (105 ter rue de Lille) 1973, 90 p. 29 F.F.

- Diagnostic phyto-ecologique et amenagement du territoire. Vol. 1. Principes genera= et methodes.
  G. LONG, Paris, Masson et Cie ed. 1974, 252 p. 110 F.F.

- An introduction to crop physiology.
  F.L. MILTHORPE and J. MOORBY. London, Cambridge University Press.
  1974, 202 p. C 1,95.

- La methode des modeles
  J.M. LEGAY et J.D. LEBRETON, Paris.
  Informatique et biosphere (105 ter rue de Lille) 1973, 150 p. 29 F.F.

- Net radiation received by a horizontal surface at the earth.
  B. de JONG, Delft University Press, 1973, 45 florins.

- Annual report 1972-73 of Division of mechanical Engineering.
  CSIRO, Griffith NSW, Australia, 66 p.

- Annual report 1973-74 of Division of irrigation Research.
  CSIRO, Griffith NSW, Australia, 66 p.

- The Rhodesian Journal of Agricultural Research, Vol. 12 N°2, 1974, 198 p.

- Le Laboratoire de Physiologie des Organes vegetaux apres recolte.
  C.N.R.S. Station du Froid, 4 ter Route des Gardes, 92190 Meudon
  1974 mimeo, 40 p. sous la direction de R. ULRICH

- Photologie Forestiere.
  L. ROUSSEL, 1972. Ed. Masson et Cie, Paris, 144 p. 48 F.F.

- Production of Early and Maincrop tomatoes in heated Glasshouses.
  Short term Leaflet 38, reviewed 1974.
  Ministry of Agriculture, Tolcarne Drive-Pinner
  Middlesex HA5 2DT Great Britain.

- 64me Colloque International des Plastiques en Agriculture
  9-15 septembre, Buenos Aires, 68 p. 35 F.F.
  Comite des Plastiques en Agriculture, B.F. 122, 92 Neuilly-surSeine.

- L'Irrigation localisee (goutte goutte).
  Colloque de Bordeaux, avril 1974, 192 P. 25 F.F.
  Invuiflec, 22 rue Bergere, Paris 9°

- Energy and environment.
  A.K. BISWAS. Environment Canada, Planning and Finance Service
  1974, 42 p. 1,5 Canadian dollar.

- Photosynthesis bibliography
  Vol. 1, part 1.
  Z. SESTAK and J. CATSKY, La Haye.
  Dr W. Junk N.V., Van Stolweg 13, 1974, 304 p. 100 florins.

c) <u>News Reviews and Publications</u>

1. <u>Soil Science Bulletin N° 1</u>
   Published by E.R. BEAUFILS - Department of Soil Science and Agro-Meteorology, University of Natal, Pietermaritzburg, Republic of South Africa.
   Bulletin N°1 with 132 pages contains information about DRIS (Diagnosis and recommendation integrated system.)

2. Microbial ecology

A new international Journal starting in spring 1974. Editor in chief : Ralph MITCHELL from Harvard University. 4 issues a year. Subscription : Springer-Verlag, New York, Heidelberg, Berlin.

3. Ornemental Horticulture

A new monthly publication for horticultural scientists dealing with ornementals, horticulturists concerned with public parks, gardens, sportgrounds and similar amenities, nursery men, students and serious amateur gardeners.
Subscription : Commonwealth Agricultural Bureaux,
Central Sales Branch, Farnham Royal, Slough SL2 3BN, U.K.

d) Events, Meetings and Exhibitions planned

1975 - April - Melle, Belgium
Azalea Symposium.
Inquiries : Dr I. van ONSEM Inst. of Ornam. Plant Growing,
Caristasstraat 21, 9230 Melle Belgium.

- April 1-4 Vienna, Austria
5th Symposium fur industriallen Pflanzenbau
Inquiries : Dr E. RANCHER, Institut fUr Botanik der T.H. Wien,
Getreidemarkt 9, 1060 Vienna, Austria.

- April 13-16 Long Ashton, U.K.
Fifth Long Ashton Symposium : Environmental Effects of Crop Physiology.
Inaugural lecture : Professor J.P. HUDSON

Session I. Weather and Microclimate
Session II. Weather and Crop Productivity
Session III. Physiological Processes I Assimilate production
Session IV. Physiological Processes : Respiration and translocation
Session V. Critical stages of Plant Development
Session VI. Modelling and Synthesis of Results.

Inquiries : Dr J.J. LANDSBERG. Microclimatology Section, Long Ashton Research Station, Bristol, BS 18-9 AF U.K.

- April 14-26 - Gembloux, Belgium
Post graduate courses : Water into protected cultivation

Topics : Agronomical aspects. - Physical characters and water disponibility of substrates. - Environmental effects. - Mineral nutrition. - Hygrometry in the greenhouses. - Evapotranspiration and water needs. - Bioclimate problems. - Water into the ground. - Model of water consumption. - Greenhouse climate. - Methods of watering.

Inquiries : Dr A. NISEN, Fac. Sc. Agron. Etat,
2, avenue de la Faculte, B 5800 Gembloix, Belgium.

- April 21 to November 4 - Rome, Italy
International Horticultural Exhibition

- April 25 to May 5 - Ghent, Belgium
Floralies gantoises - 27th International Horticultural Exhibition

Inquiries : Floralies Gantoises
265 Burg Charles de Kerchovelaan, Ghent, Belgium.

- May 13-16 - Rijswijk (near The Hague) The Netherlands
  Symposium : New developments in the control of glasshouse environment.

  Session 1. Control of growing conditions in the greenhouse
  2. Control of growing conditions in the soil
  3. Climate requirements of vegetable crops
  4. Climate requirements of flower crops
  5. Other specific aspects of protected cultivation

  Information : Proefstation voor de Groenten en Fruitteelt under Glass - Zuidweg 38, Naaldwijk, The Netherlands.

- July 3-10, Leningrad, USSR
  12th International Botanical Congress. Includes 18 sections :
  1. Nomenclature - 2. Systematic and Evolutionary Botany - 3. Phycology 4. Mycology and Lichenology - 5. Bryology - 6. Vascular Plants - 7. Floristics and Phytogeography 8. Ecological Botany - 9. Structural Botany - 10. Growth and Development - 11. Metabolism and Regulation - 12. Photosynthesis - 13. Mineral nutrition - 1 4. Water Relations and Resistance to Extreme Environmental Conditions.- 15. Immunity - 16. Cultivated Plants and Natural Plant Resources - 17. History of Botany and Botanical Bibliography - 18. Conservation of the Plant World.

  In section 10 there is symposium N°7 : Phytotronics Organizers : A.F. KLESHNIN (USSR), V.M. LEMAN (USSR}. Chairman F.W. WENT (USA).

  Topics : Introduction by the Chairman.
  Perspective of phytotronics in plant life science (P. CHOUARD).
  The physiology of flowering and yield determination (L.T. EVANS).
  Potential plant productivity and methods of its regulation (B.S. MOSCHKOV).
  Optimal regulation of phytotron (A.F. KLESHNIN
  Discussion and concluding remarks by the Chairman.

  "Secretariat Phytotronique" hopes to have the opportunity to organize (see page 23) one or more Round Table discussions and will publish a book on the Symposium and eventually other Round Table discussions.

  Inquiries : Organizing Committee of 12th International Botanical Congress, Komarov Botanical Institute, 2 Prof. Popov Street, Leningrad 197022, USSR.

- August 12-17 - Kumasi Ghana.
  4th African Horticultural Symposium. Current research on horticultural crops in West Africa.
  Final date of application : June 1st 1975.

  Inquiries *Mr* J.C. NORMAN, Department of Horticulture, University of Science and Technology, Kumasi, Ghana.

- August 21-27 - Moscow, USSR
  VIIth International Congress of plant Protection

Topics : 1. Plant protection in USSR - 2. Plant protection and environment - 3. Economics in plant protection - 4. Chemical control - 5. The Role of meteorology in forecasting - 6. Biological control - 7. Integrated control.

Information : Secretariat of the Organizing Committee
1/11 - Orlikov per. - 107139 Moscow B-139 USSR

- August 23-31 - Goteborg, Sweden
International Conference Garden Center I.G.A.
Inquiries : I.G.A. Conference c/o Svenska Massan
Stiffelse Skanegatan 26 S412-51 Goteborg, Sweden.

- September 3-6 - Copenhagen, Denmark
Conference of European Landscape Contractors Association (ELCA)
Inquiries : UNSEPF - 8, rue St Marc, 75002 Paris (France).

- September 6-11 - Budapest, Hungary
7th International Conference on Rural Electrification, Section IV - Rural Electrification.

Themes : 1. Development, prediction and economic problems of power and energy needs of specialized concentrated agricultural plants - 2. Rational energy needs of agricultural production and working processes with a special view to automation and control techniques - 3. Role of electric power in the thermal power supply - Possibilities of refrigeration and heat recovery - 4. Research problems of electrification in various countries.

Information Dr Ing. Zoltan SIBALSKY, President Organizing Committee
Hungarian Electrotechnical Association
1055 Budapest, Kossuth Lajos ter 6-8 Hungary

Final date of application : March 31, 1975.

- September 8-12 - Gembloux, Belgium
Week study : Agriculture and Plant Hygiene

Topics : Genetics and Plant Hygiene.
Sanitary state and Phytotechnie - New possibilities of pest control. Chemicals. Biological means. Dynamics of plant parasite populations. Sanitary quality of yields. Economic Balance Sheet for Plant Protection

Information Semaine d'Etude de ltAgriculture et Hygine des Plantes
2, Passage des Deportes, B-5800 Gembloix, Belgium

- September 23-26 - Grignon, France
Permanent formation studies :.Mecanism of photosynthesis and plant production.

Information : Centre de Perfectionnement INA, 16, rue Claude Bernard
75231 Paris.

- September 29-October 1 (1st Session)
October 6-8 (2nd Session) - Paris, France
Permanent formation studies : Nutrient solutions for plant cultivation in artificial medium.

Information : Centre de Perfectionnement INA,
16, rue Claude Bernard, 75231 Paris.

- October 19-22 - Sofia, Bulgaria.
  II. Symposium on plant growth regulators

  Organized by M. POPOV, Institute of Plant Physiology, Academy of Sciences, Academy of Agricultural Sciences Ministry of Agriculture and food Industry and the Scientific technical Union of Agriculturists.

  Topics : 1. Regulation of plant growth and development - general problems - 2. Natural regulators - 3. Synthetic regulators - 4. Application of growth regulators.

  A special Symposium review is envisaged to be published in Russian and English.

  Inquiries : 2nd Symposium on Plant Growth Regulators
  M. POPOV, Institute of Plant Physiology
  36 Street, Block 6
  Sofia, 13, Bulgaria

1976 - Switzerland
Symposium on Labour and Labour management

Information : Dr A. WIRTH, Swiss Federal Res. Station for Arboriculture, Viticulture and Horticulture,
8820, Wadenswill, Switzerland.

- Peru
  symposium on Tropical Fruits

  Information : Dr H. HOLLE, Department of Horticulture
  Univ. Nac. Agraria, Apt 456 Lamolina-Lima, Peru.

- Quebec, Canada.
  International Floralies of Quebec

  Information : Organizing Committee, 2527 Gregg str.
  Sainte Foy, Quebec, Canada 61 W1 J5

- Spring - Pont de la Marge, Switzerland
  Cucumbercae under protection

  Inquiries : Dr G. PERRAUDIN,
  Station Federale de Recherches Agronomiques
  1962, Pont de la Norge, Switzerland.

- Spring - Copenhagen, Denmark
  Symposium on Propagation problems in Arboriculture

  Information : Prof. A. XLOUGART, Department of Horticulture
  Royal Veterinary and Agricultural University
  1958 Rollighedsvej 23, Kobnhavn, 5, Denmark.

1976 - August - Vollebekk, Norway
Symposium on Floriculture : environment and growth

Information : Prof. E. Stromme, Department of Floriculture
Agric. College of Norway, Aas-NLH Box 13, 1432 Vollebekk, Norway.

- August 30-September 4 - Lausanne, Switzerland
9th International Conference on plant growth substances.

Four topics :
1. Regulative role of hormones in cell metabolism
2. Significance of hormone balance in growth and senescence processes
3. Wall extension : ultrastructural problems, enzymology, biochemical and biophysical analyses, relation to the plasmalemma.
4. Photo and georeaction (Kinetics and receptors) associated with growth processes.

Registration : not later than May 31, 1975.
Prof. P.E. FILET,
Institut de Biologie et de Physiologie vegetales de l'Universite,
Place de la Riponne, 1005 Lausanne, Switzerland.

1978 - Sydney, Australia
20th International Horticultural Conference

Information : Mr G.R. GREGORY
Chief Division of Horticulture of the N.S.W.
Dept. of Agriculture, Sydney,Australia.

1982 - Hambourg, Germany FRG
21st International Horticultural Conference

Information : Prof D. FRITZ, Institut fur Gemusebau 8050
Weihenstephan - Freising/OBS, Germany, Fed. Rep.

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We thank, in advance, all those who will be sending us documents or news to print in coming issues.

P. CHOUARD and N. de BILDERLING