Secretariat Phytotronique
C. N. R. S.
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PHYTOTRON1C NEWSLETTER N² 21

Contents

Informations and news

I EDITORIAL

Over one year has passed since the publication of our previous issue - (N° 20 September 1979). We hope that you will excuse this long delay, due enti - rely to financial problems The publication of this current issue was made possible only with the help of a special grant from the Directors of the Centre National de Recherche Scientifique

Our thanks especially go to all those who helped with the current issue,

Admini strative Directorship of the Phytotron a Gif-sur-Yvette

Ever since the retirement of Professor Emiritus Pierre Chouard in 1975 the Administrative Directorship of the Phytotron has been assured by Paul Champagnat Professor of Plant Physiology at the University of Ctermont Ferrand, with Roger Jacques as Assistant Director (Phytotronic Newsletter, N° 12-13, April 1976 p, 3).

On October 1, 1979 Professor Champagnat ended his term as Director and retourned to the University of Clermont Ferrand (Plant Physiology Laboratory, 4 - 6 Rue Ledru, 63000 Clermont Ferrand, France).

From this time on, Dr. Roger Jacques was named to the position of Director of the Phytotron for a five *year* renewable term.

We would like to take this opportunity to extend thanks from our readers and the Phytotron personnel to Professor Champagnat for all the work that he accomplished during his term of office and we offer our good wishes to Dr. Jacques for the action he is undertaking at the Phytotron..

N. de Bilderling

The current issue contains news or articles divided as usual into four sections

Annual Reports and Meetings. containing various extracts from Reports. We have al so included in this section a list of the articles which have appeared in the Phytotronic Newsletter since its founding as a result of the many requests received by our readers..

In the section News from Laboratories Institutes and Partnership we are following suggestions from our readers, publishing a list of Phytotrons and other important centers giving their addresses and general research orientation. A description of the Phytotron of Shanghai has been sent to us, news from the Phytotron of Gif-sur-Yvette; as well as, news from the Societies, ESNA and Arabidopsis Information Science.

In the section on Research Strategies various articles and scientific paper are printed dealing with results obtained, modelization, or technical equipment developed in laboratories,

Finally, in Miscellaneous Informations and News, we publish some details about scientific materials (Li-Cor Instruments), an analysis of several books, and news about coming meeting or exhibits.

R. Jacques and N. de Bilderling

II REPORT 1978. PHYTOTRON N C S U (USA)

Editor's Note. Report 1976 of the Phytotron of North Carolina State University (NCSU) have 145 pages. We reprint certain passages which can interest our readers. Those who desire more informations please write to : NCSU-SEPEL 2003 Garnder Hall. Raleigh N C 27607 USA.

Introduction

During 1978 investigations of air flow and control valve operation enabled us to improve the performance of our reach in C-chambers that had been converted from direct expansion to secondary coolant refrigeration. Relative humidity studies in these chambers resulted in an automated watering and drainage system that allows the experiment to proceed with disturbances such as opening the chamber door.

Fan life in chambers like ours that use muffin fans for internal air circulation has never approached the manufactures' rating; even though some of the chambers are operated at or very near the optimum temperature for the fans. Dismantling, rebuilding and testing of these fans provided us with the cause of the premature failures. Solutions to the problem would seem to require a modification in manufacturing techniques. Since the manufacturer is unlikely to make these changes, we are currently evaluating other fan types that can serve as: replacements.

Fluorescent lamps with built-in reflectors are supposed to provide 20.25Z more illumination than those without such reflectors. Since the reflectorized lamps produce less light per lamp than non reflectorized ones, this increase is obtained only when a relatively large number of reflectored lamps are mounted very closely together as they are in many plant growth chambers. Under growth chamber conditions the merit of a highly reflecting surface above the lamps is debatable. Our studies show that a reflective ceiling above close packed, 23/m, non reflectored lamps results in about the same illuminance as obtained with reflectorized lamps without the reflective background. We have reason to believe that lumen maintenance and manufacturing quality control is better with the non reflectorized lamps than with lamps having a built-in reflector. Studies to obtain comparative data are in progress.

Commercial peat-lite mixes are excellent substrates far growing plants. However, nutrient chemicals such as limestone, super phosphate and calcium nitrate are added by the manufacturers to the substantial amounts of potassium and magnesium available from the vermiculite component. As a result the nutrient solution must be balanced against the added elements. Moreover, nutrient solution applied immediately after planting or after moving plants to larger containers can result in disastrous imbalances and toxicities. Consequently, we developed the practice of flushing the peat-lite with enough water to reduce the conductivity to about the level of city water. A detailed analysis of our nutrient solution resulted in a change in formulation, primarily increasing the potassium level (Table 1).

Table 1.

N. C. S. U. Phytotron Nutrient Solution.

Stock solution	Formula Weight	gms/liter of stock. soln
Magnesium nitrate	256.41	65.0
Calcium nitrate	236.15	160.0
Sequestrene 330 Fe		25.0
B		
Ammonium nitrate	80.04	40.0
Potassium nitrate	101.11	101.1
Potassium phosphate (monobasic)	136.09	12.0
Potassium phosphate (dibasic)	174.18	14.0
Potassium sulphate	174.27	15.0
Sodiul sulphate	142.04	17.0
"B" Micro		mg/liter of stock soln
Boric acid	61.83	700.0
Molybdic acid	179.97	5.0
Hampene zinc 14.5% Zn		45.0
Manganous chloride	197.91	204.0
Hampal cooper 9.0% Cu		30.0
Sequestrene cobalt 14.0% Co		1.0
Uranine		750.0

On an annual basis, use values of 85% or more indicate continual use because of the time lag between the termination of one experiment and the beginning of the next. For example, when a project is completed on Thursday of Friday, the next investigator rarely is ready to start his study before the following Monday. One or two percent use is also required for normal clean-up and maintenance. This is the equivalent of shutting down each unit for one or two days every quarter.

Malfunctions caused a loss of 0.3% of the total unit days. More specifically, most of the malfunctions occurred in the direct expansion C-chambers that have not yet been converted to secondary coolant. However, our reporting methods make the validify of downtime losses due to malfunction somewhat unreliable. For example, a 1% C-chamber malfunction loss amounts to 73 chamber days. Since seven C-chamber malfunctions occurred, eachunit would seem to have been lost for about 10 days. The remaining 4 malfunctions occurred in the A-chambers and the records indicate a loss of 28 chamber days or 7 days per malfunction. This was not the case however. When 'the malfunction occurred the research. was moved immediately to another unit but after the malfunction was corrected, there was often no compelling reason to return the plant material immediately. Thus a malfunction that would cause one day of downtime could be reported in our data as 7 days.

Ranking space use by crop type includes plants used in basic studies that are not actually grown as crops. Ranking *am* tobacco crops, therefore, would include *species* like Nicotiana thyrsiflora as well as commercial tobacco and corn research would include *exotic types* as well as currently grown varieties. Of the space used, vegetable crops used the most followed by soybeans and corn. Tobacco ranked 4th in space use. Most of the space utilized by vegetable crops is explained by the role of snap bean in air pollution research and the work of Dr. Benepal on bean beetle resistance.

Off-campus investigators occupied an average of 20% of the *space* used, with a maximum of 36%. The space requests from visiting scientists for 1979 indicate that we must plan for 40% or more of the space to be allocated to off-campus people.

Space Use: Fifty five space requests were submitted in 1978. A number of these were revised following an initial evaluation. Fifty hour projects were finally approved. The number of proposals per field was:

Agri.Eng.	1	Horticulture	13
Botany	5	Pathology	4
Crop Science	11	Soil Science	6
Entomology	2	Microbiology	1
Forestry	3	Zoology	1
Genetics	5	Visiting Scientists	2

A computer program for developing space use data was evaluated in 1978 and will go into full operation in 1979. As a result of this program Phytotron space is calculated in terms of unit-days, where one unit equals one truck or equivalent area of 4 ft^2. Since the various kinds of controlled environment space is not used in exactly the same way, space use is shown for each chamber type as percent of possible use.

Chamber Type	Percent Use/Quarter				Annual Use
	1	2	3	4	
Standard A-chambers	74	84	82	80	80
Assigned A-chambers	99	67	86	86	84
B-chambers	83	95	89	98	91
C-chambers	66	96	79	84	81
Glasshouses	73	55	56	67	63

List of the investigations durins 1978:

Air pollution research

H. H. ROGERS and al. Use of the Phytotron to study the interaction of atmospheric chemicals and plants.
P. S. BENEPAL and al. Screening beans for resistance to air pollutants.
P. S. BENEPAL and al. Effect of air pollutant ozone and seed color on protein content of beans.

Entomology

G. G. KENNEDY and R. T. YAMAMOTO. Effect of daylength and light intensity on the expression of resistance to tobacco HORNWORM *in* Lycopersicum hirsucum F. Glabratum.

P. A. BENEPAL and M. RANGAPPA. Techniques of screening beans for resistance to Mexican bean beetle.

P. S. BENEPAL and al. Influence of ozone on. Mexican bean beetle resistance in beans Phaseolus vulgaris L.
G. G. KENNEDY. Effect of photoperiod and light intensity on expression of resistance in Lycopersicon sp. to tomato fruit worm and tobacco hornworm.
T. E. ANDERSON and G. G. KENNEDY. Influence of temperature on diapause termination and development of the European corn borer.

Environmental physiology

J. F. THOMAS and C. D. RAPER Jr. Environmental physiology of Glycine max (L.) Merrill effect of length of photoperiod on floral initiation and anthesis.
GROSS H. D. Effect of environment on soybean reproduction.
LARSON R. A. Effect of temperature and photoperiod on flowering of Gloxinia.
LARSON R. A. and V. P. BONAMINIO. Influence of temperature on flower bud initiation and development of Chrysanthemum.
DOWNS R. J. and L. G. BURK. Environmental conditions affecting flower initiation, development and seed production in the genus Nicotiana.
THOMPSON D. L. Effect of photoperiod on Gaspe Flint corn.
THOMPSON D. L. Thermal units as related to pollen shedding and silking in corn. BENEPAL P. S. Amino acid and protein analysis of selected bean germplasm under controlled-environmental conditions.
FELLOWS R. J., H. D. GROSS and R. P. PATTERSON. Water stress recovery in soybean: correlation of net photosynthesis; nitrogen fixation, carbohydrate distribution and nodule adenylate levels.
SCOTT, Jennifer and R. P. PATTERSON. Effects of water stress and long photoperiods on rate and duration of seed fill, plant senescence and yield in two soybean varieties.

Genetics

C. L. NESSLER and E. A. WERNSMAN. Electron-microscopic examination of extranuclear temperature-sensitive lethality in Nicotiana tabacum L.
W. K. RUSSEL and C. W. STUBER. Genetic analysis of the maturity genotype of maize. W. D. HANSON. Genotypic differences affecting utilization of Photosynthate. I. Modified source-Sing Linkages during Vegetative growth. II. Modification of Carbon Exchange Rates through Source-Sink Linkage. III. Translocation Rates as affected by Source-Sink Linkages.
RUSSEL W. K. Inheritance of photoperiodic sensitivity among in breeds of differing maturities.
GAUTNEY T. L. and F. L. HAYNES. Breeding diploid potatoes for beat tolerance.
EMERY D. A. Genetic control of reproductive efficiency in peanuts; response to photoperiod.
NESSLER C. L. and E. A. WERNSMAN. Biochemical and ultrastructural investigation of the cytoplasmic basis for extranuclear temperature sensitive lethality in Nicotiana tabacum.
MURPHY C. F. Increase of F1 wheat plans using the Phytotron to intensify the wheat breeding program.
HANSON W. D. Differences in rates of C 14 translocation in the petiole and stems among soybean genotypes.

Germination

T. O. BOST and R. J. DOWNS. Factors related to Kalmia latifolia seed germination.

BEAUFORT MURPHY Helen. Investigation of seed size and germination capability in relation to position in the fruit of selected Streptocarpus species.
JOHNSON E. L. and G. R. NOGGLE. Structural and physiological changes induced to Myriophyllum spicatum in varying concentrations of salinity during seed germination and early seedling growth.
DOWNS R. J. and L. G. BUNE. Changes in the germination physiology of seeds of Nicotiana species due to environmental conditions during seed maturation.
EL GHEWRI, S. And H. SELTMANN. Factors affecting seedling uniformity in tobacco. R. W. JONES and D. C. SANDERS. The influence of soaking Pepper Seed in water or Potassium salt solutions on germination at 3 temperatures.
K. W. JONES and D. C. SANDERS. The influence of Preplant Soaking Phosphorus, and watering Frequencies on the germination and Emergence of Plug Mix seeded peppers.

Horticulture

P. V. NELSON and P. ATKINS. Cultural requirements for the commercial production of Stapelia as a potted plant.
LARSON R. A. And V. P. BONAMINIO. Effectiveness of multipl6k low rates of application of A-Rest in controlling heights of Poinsettias grown in controlled environments.
SHALTOUT A. D. and C. R. UNRATH. Chill unit model development as affected by environmental factors.

Nutrition

R. P. PATTERSON and R. JONES. Nitrogen - temperature interactions in Soybeans (Glycine max L. Merr.).
P. E. BISHOP. Screening Rhizobium mutaReus.
H. E. PATTEE. Developmental Physiology of the peanut: Interaction of Calcium nutrition and temperature during the developmental and differentiation of the pod. RAPER C. D., Jr. And R. P. PATTERSON. Influence of root temperature and nitrate concentration on nitrogen fixation of soybean.
FELLOW, R. J., H. D. GROSS and R. P. PATTERSON. Influence of nodule adenylate energy charge on recovery rates of nitrogen fixation in soybean.
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OSMOND, Deanna. Interation and antagonism of K^+ and NO_3- ions.
COX F. Growth and Mn uptake patterns of Bragg soybean grown under various conditions of temperature.
DE SOUZA P. and H. D. GROSS. Physiological studies of soybean roots.

Tissue and cell culture

S. M. FLASHMAN and P. L. TRAYNOR. Hormonal Effects on the regeneration of Tobacco plants from Long - term Callus Cultures.
S. FLASHMAN Selection of spontaneous and mutagen - induced Selenoamino acid resistant cell lines from suspension cultures of Nicotiana tabacum and Nicotiana sylvestris.
R. L. MOTT, L. E. MATTINGLY and M. HORNER. Environmental effects on morphogenesis from plant tissue culture.
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HORNER M. and R. L. MOTT. Effects of temperature shocks and 2 CEPA on pollen development and anther culture of tobacco.

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LEONARD K. J. and R. J. CZOCHON. Predisposing effect of light relative to genetic susceptability in two diseases of corn, Anthracnose and Southern corn leaf blight.

Tree physiology

E. B. SCHULTZ. Cold - hardiness testing of Eucalyptus.
MILLER L. K. Growth and CO2 uptake of Fraser fir seedlings under two temperature regimes.
ROSE R. Sucrose levels in Eucalyptus ***species*** roots and infection by ectomycorrhizal fungi.

Zoology

H. UNDERWOOD. Photoperiodism in the male lizard Anolis carolinensis an anlysis of the Hourglass timer.

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RAPER C. D. and Judith F. THOMAS. Photoperiodic alteration of dry matter partitioning and seed yield in soybeans. Crop Sci. 18, 654-656.
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III. ANNUAL REPORT 1979 OF THE UNIT OF COMPARATIVE PLANT ECOLOGY OF THE UNIVERSITY OF SHEFFIELD (UK)

Editor's Note. Dr. I. H. Rorison has sent us their annual report with items of current work which may be of interest to our readers. Following we publish some extracts. Those who want more information please write to: Unit of Comparative Plant Ecology (NERC) Department of Botany. Sheffield S 10 2TN UK.

The Unit of Comparative plant Ecology originated in 1961 as the Grassland Research Unit and was funded by the former Nature Conservancy. It has been supported directly by the Natural Environment Research Council since 1973 and adopted its present name in 1974. The Unit *is* making a fundamental study of the mechanisms controlling plant distribution and the structure vegetation, gaining understanding of the responses and tolerance of species and of individuals to a range of environments, and formulating predictive approaches to plant competition and distribution. It is also concerned with the transmission of information bases on its research to applied scientists and non biologists dealing with vegetation management and habitat reconstruction. The staff contribute to the training of postgraduate students (currently 9) and to the formal teaching programme of the Department of Sotany at Sheffield University.

Our objectives include (a) the recognition of the primary strategies that result from the main pathways of evolutionary specialization in autotrophic plants and (b) a description of the role of these strategies in vegetation processes and in the determination of the structure and species composition of plant communities.

During the current quinquennium (1979-84) our efforts will be concentrated on nine major projects. These are:

1. Vegetation surveys
2. Screening of herbaceous plants of contrasted ecology
3. Plant strategies
4. Phenolo*, demography and regeneration in herbaceous vegetation
5. Comparative studies in mineral nutrition
6. Climate, mineral nutrition, topography and plant distribution
7. Plant growth analysis
8. Liaison with other workers in both pure and applied ecology
9. Technical developments.

Introduction

This year the various aspects of our work are reported in a new sequence which reflects the form of our research programme for the new quinquennium. Projects are listed and details are recorded in the main NERC HQ register. An outline of the aims of each project is given as a preface to each section and this is followed by accounts of major growth points.

The field surveys (Project I) are in the final phase of analysis and interpretation. The screening programme (Project 2) is designed to quantify the processes of seed dormancy, germination, growth and physiology under stress which are characteristic of plants associated with the principal types of terrestrial habitats. This work is a major commitment up to 1984 and is linked with field studies especially concerned with the mechanisms controlling species density and regeneration (Project 4). Detailed studies of mineral nutrition (Project 5) and climatic response (Project 6) of plants experiencing both diurnal and seasonal fluctuations are under way and will also represent a major and related effort in the current quinquennium. Projects 7, 8 and 9 are designed, in part, to service Projects 1, 2, 4, 5 and 6, all forming the basis for the development of Project 3.

One of our concerns in the synthesis of our laboratory and field work and we are continuing to assess its predictive value both in environmental planning and in the development of ecological theory. Some of the concepts developed in Sheffield form the basis of two books. The first, Plant strategies and vegetation processes by J. P. Grime, is just published and the second, Amenity grassland: an ecological perspective edited by I. H. Rorison and R. Hunt, is due to appear at the end of 1979.

The amenity grassland volume records the fourteen main contribution made at a second meeting for UK research workers held in Sheffield in December 1978 (the first being at Liverpool in 1976). The aim was to provide a concise review of current knowledge and to highlight areas in which the interchange of ideas between turfgrass specialists, ecologists and managers was considered timely. While developing the theme of NERC's Amenity grasslands - the needs for research (1977), we emphasized the ecological principles relevant both to intensively managed turfgrass and to extensive, semi natural grasslands.

1. Vegetation surveys

Our aims have been threefold: to describe the floristic composition of the habitats within an area of c. I000 square miles around Sheffield: to obtain standardized descriptions of the field ecology of c.900 herbaceous species; to provide rapid access to standardized field data for interested parties.

2. Screening of herbaceous plants of contrasted ecology

In a series of laboratory screening experiments, a wide range of plants is being subjected to various standardized treatments and measurements in an attempt to recognize types of seed dormancy, germination, growth and stress physiology characteristic of particular ecologies.

Effects of temperature on plant growth

(a) Completion and **use** of the new temperature - gradient tunnel

The prototype (Mason, Grime & Lumb, Annals of Botany, 40, 137 (1976), has been followed by the development of a tunnel designed to accomodate larger experiments and to provide more standardized growth conditions. The new tunnel allows plants to be grown simultaneously in ten temperature regimes under controlled conditions of light, wind speed and atmospheric humidity. Some of the main features of the new tunnel are illustrated in Figures I and 2. It differs from the prototype in the following ways.

(1) The width of the plant chamber has been enlarged from 0.3m to I.3m in order to accomodate a greater number of species and/or replicates at each temperature. A maximum of 45 plant pots (75 mm square) may be used in each of ten compartments.
(2) Access to the interior of the tunnel **is** by means of the doors which form the side walls of the tunnel and are hinged at the base.
(3) The cold airstream entering the tunnel originates from a large, well insulated box containing an evaporator unit suspended from its roof. The refrigeration unit is connected to a compressor situated outside the building. Cold air is drawn into the tunnel airstream by means of four fans with variable speed controls.
(4) In the prototype, warm air was injected laterally into the airstream through inlets in the side walls of the tunnel and high vapour pressures were maintained by atomizers mounted below the tunnel roof. In the new tunnel the source of heated, humidified air is a common chamber situated beneath the tunnel. In this chamber the air is heated to a temperature of approximately 45°C and saturated with water vapour by means of four large atomizers, operated by compressed air. Air from this large reservoir is directed upwards into the tunnel via ten antechambers lying immediately under the tunnel and opening into it through holes in the floor of the plant chamber (see Figures 1p and 2p).

(5) Temperatures on the right and left sides of the tunnel are balanced by altering the volume of air entering from opposite ends of the antechambers. This is achieved by raising or lowering flaps which are positioned over the row of holes which admit heated air through the floor of the tunnel.
(6) Fine control of temperature is provided by paired fan heaters each of which is located in a side compartment and opens via a simple ball-valve through the side wall of the antechamber. Each pair of fan heaters is activated by a thermistor suspended in the middle of the tunnel air-stream.
(7) The temperature regimes can be adjusted by means of a temperature control unit comprising ten identical control modules with a common power supply.
(8) The source of illumination *consists* of fourteen metal halide lamps arranged in two rows and suspended within a lamp house situated above glass tanks containing 50 mm of water which acts as a heat filter.
(9) The objective in the prototype was to produce a continuous gradient in temperature within the airs-tream. In the modified tunnel transparent perspex baffles are suspended transversely from the glass roof of the tunnel, effectively diverting the airstream through a **series** of ten compartments. The baffles are situated immediately in advance of the transverse rows of holes through which air injection occurs from each antechamber. The result of this arrangement is to produce a stepwise increase in temperature along the length of the tunnel and to provide ten areas of equal size, each experiencing a relatively uniform temperature.

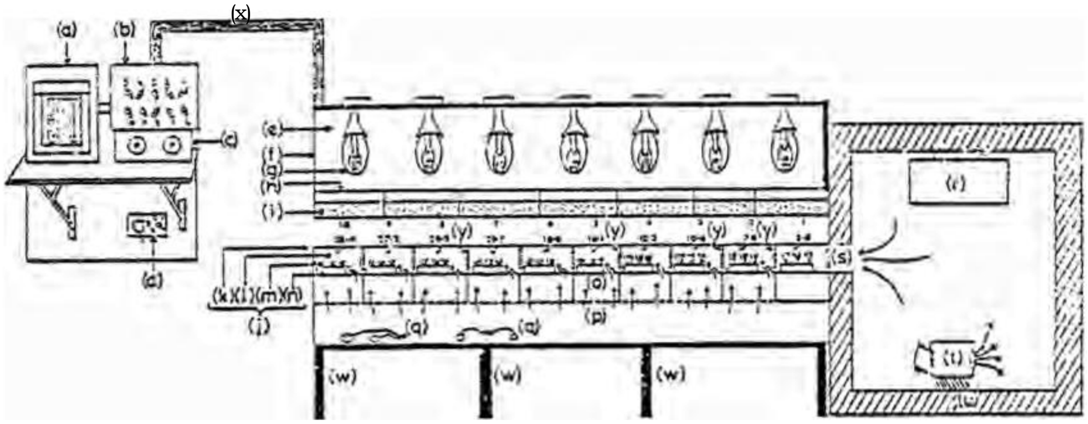

FIGURE 1
Longitudinal vertical section (not to scale) of the tamperature-gradient tunnel: (a) temperature recording equipment, (b) temperature control panel, (c) speed controls for fans (s), (d) speed control for fan (t), (e) 'amp house, (f) lamp reflector, (g) metal halide lamp. (h) heat filter, (i) water (50 mm deep), (j) series of plant chambers, (k) glass roof of plant chambers, (1) therrniator, (in) plants in pots, (n) tray containing plant pots, (o) antechamber, (p) heating and humidification chamber, (q) tubular heater connected to thermostat, (r) fan compartment of refrigeration unit, (s) one of four fans controlling output from cold reservoir into plant chambers, (t) fan controlling air flow into cold reservoir, (u) insulation, (v) flaps controlling input of moist warm air into plant chamber, (w) legs, (z) thermistor leads, (y) incomplete partition between plant chambers.

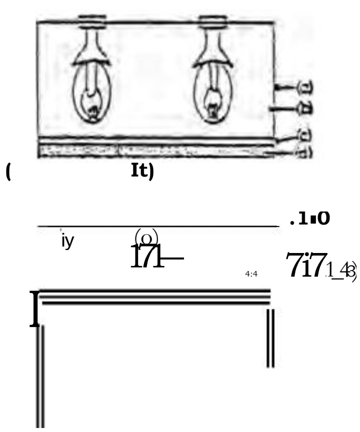

FIGURE 2
Transverse vertical section (not to scale) of the temperature-gradient tunnel: (a) lamp house, (b) metal halide lamps, (c) heat filter, (d) water (50 mna. deep), (a) recording thermistor, (*j*) control thermistor, (g) glass roof, (h) hinged door, (i) plastic container holding plant pots, (j) plants, (k) flaps, (I) side compartment, (m) fan heater, (n) hail valve, (o) antechamber, (g) heating and humidification chamber, (q) compressed air supply, (r) water supply, (s) atomizer, (t) tubular heater with thermostat. (u) legs.

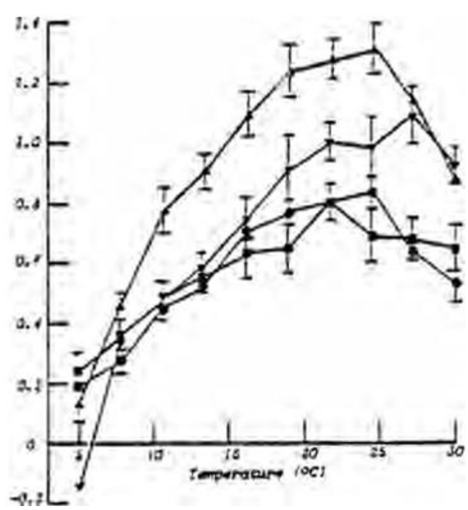

FIGURE 3
The effect of temperature on mean relative growth rate in seedlings of: • , *Deschampsia flexteosa;* **a,** *Galeobdoion luteurn;* • , *Poa trivialic* • , *Urtica dioica.*
Measurements spanned four weeks; 95 percent limits are given.

***New relative growl(* rata**
tweak 1

(b) Results from the temperature gradient tunnel

Figure 3 provides an illustration of data obtained using the new tunnel. These results are drawn from an experiment in which growth responses to temperature were compared in a range of woodland plants of contrasted phonology and ecology. From these data it is apparent that the response to temperature of the two potentially productive species associated with moderate intensities of shade and fertile soils (Urtica dioica, Poa trivialis) is rather different from that of the two evergreen, shade tolerant herbs (Galeob•dolon luteum, Deschampsia flexuosa).

3. Plant strategies

By referring to data collected by UCPE, and from other sources, an attempt is made to describe the main avenues of adaptive and ecological specialization (i. E. the primary strategies) in plants and animals. Strategies in the established and regenerative phases of plant life histories have been recognized and these are providing a basis for the analysis of the processes controlling the structure and dynamics of vegetation.

4. Phenology, demography and regeneration in herbaceous vegetation

Seasonal and year to year changes in the dry weight and species composition of the total shoot biomass are being measured at a number of field sites and studies are in progress to examine the role of vegetative and sexual processes of regeneration in the survival of populations and in the maintenance of species diversity in contrasted types of herbaceous vegetation.

5. Comparative studies in mineral nutrition

We aim firstly to recognize critical mineral nutritional factors in the field, clarifying their effects by laboratory simulation, and secondly to ***assess*** to role of these factors in plant distribution.

6. Climate, mineral nutrition, topography and plant distribution

To understand the toleracnes of species and populations to a range of environments measured in the field we assess the importance of the responses of the same species to factors varied individually under laboratory conditions.

7. Plant growth analysis

Here we aim to explore the most appropriate ways of describing plant growth and of interpreting it in relation to environmental conditions. Both have the aim of developing comparative tools. We make a critical appraisal of current methods and identify areas of conceptual or practical weakness. Remedies are evaluated and are often disseminated in the form of computer programs for general use.

8. Liaison

We aim to transmit information based on our research to other workers in both pure and applied ecology, and to collaborate in work of common interest. Feeback from both types of contact can result inimommendations for our main programme.

9. Technical developments

Techniques and equipment are required to measure climate in the field and to provide a controlled environment in the laboratory. This latter includes the simulation of field climates and the provision of variable flow nutrient cultures for *use* in the study of germination and of plant growth.

Publications 1978-79

Al Mufti M. M. 1978. A quantitative and phenological study of the herbaceous vegetation in the deciduous woodland at Totley (S. Yorks) Ph. D. Chesis, University of Sheffield.

Bayliss J. M. Uneson P. R.) & Rorison I. H. 1979. The extent of belland ground adjacent to Tideslow and Maiden Rakes ... Little Hucklow. Bulletin of the Peak District Mines Historical Society 7, 153-57.

Grime J. P. 1979. Plant strategies and vegetation processes John Wiley, London.

Grime J. P. 1979. Interpretation of small scale patterns in the distribution of plant species in space and time. Structure and functionning of plant populations (ed. by J. W. Wolden$dorp) pp. 101-124. Verhandelingen der Koninklijke Nederlandse Akademit van Wetenschappem, Afdeling Natuurkunde, Tweede Reeks, deel 70, 1978.

Grime J. P. 1979. Primary strategies in plants. Transactions of the Botanical Society of Edinburgh 43, 151-60.

Gupta P. L. 1979. Changes in the forms of phosphorus and of nitrogen in soil and their availability to plants. Ph. D. Thesis, University of Sheffield.

Hunt R. 1979. Plant growth analysis:the rationale behind the use of the fitted mathematical function. Annals of Botany 43, 243-49.

Nazrul Islam A. K. M. & Rorison I. H. 1978. Field investigations of seasonal oxidation-reduction conditions in soil and of changes in the mineral contents of shoots of associated species. Dacca University Studies 3. 26 , 57-65.

Steal L. 1979. An investigation into the pattern of regeneration within gaps and the type of seed bank on a north-facing slope and a soutb-facing slope at Millersdale near Litton. g. Sc. Thesis, University of Utrecht.

X x x x

IV. INTERNATIONAL COURSE ON IRRIGATION

The 12th International Course on Irrigation will be held at the Institute of Soils and Water, A. R. O. Volcani Center, Bet Dagen Israel from the 13 october to the 11 december 1980.

Main topics of the course

A. Water Resources for Irrigation

1. Development and management of water resources
2. Exploration and exploitation of ground water
3. Rainwater harvesting
4. Unconventional water sources

B. Soil properties in relation to Irrigation
1. Physical properties of soil
2. Chemical properties of soil.

C. Soil - water - Plant Relations
1. Physical aspects of irrigation
2. Water retention and water flow in soils
3. Water transfer from soil to plant
4. Ion exchange phenomena and solute movement

D. Agricultural Meteorology
I. Climate and irrigation
2. Evapotranspiration
3. Micro climatic conditions

E. Salinity in irrigation
1. Water quality
2. Soil salinity and sodicity
3. Plant response to salinity

F. Fertility and irrigation
1. Principles of fertilization
2. Combination of fertilization and irrigation (fertigation)

G. Irrigation technology
1. Furrow and gravity irrigation
2. Sprinkler irrigation
3. Drip irrigation
4. Automation and programming
5. Special irrigation techniques
6. Irrigation equipment.

H. Crop - water requirements
1. Prediction of irrigation needs
2. Field crops
3. Vegetables
4. Fruit Trees

I. Extension methods

J. Economic aspects
1. Water policy
2. Economic considerations of irrigation techniques

K. Sources of information on irrigation

L. Seminars given by participants.

General information

All courses are held in English.

The cost of the two month course, including board and lodging, tuition, field excursions and study material is US $ 1700. This does not include travel expenses to and from Israel.

For further details please contact:

Dr. K. M. SCHALLINGER. Course Director. International courses. Volcani Center. P. O. Box 6. Bet Dagan Israel.

V. ESNA. EUROPEAN SOCIETY OF NUCLEAR METHODS IN AGRICULTURE

Editor's Note.

The secretariat of ESNA has kindly sent us: Newsletter n°11-September 1979. We reprint below table of contents. These readers who want to receive this numero please write to: Association Euratom - ITAL. PO Box 48. Wageningen (The Netherlands).

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Editor. A. R. Krantz. Fachbereich Biologie (Botanik) der Universitat. Siesmayerstr.70. D 6000 Frankfurt/Main. Federal Republic Germany.

Content no 16 october 1979 (119 pages)

A. Original Contributions

B. Short Communications

ACEDO Gregoria N. A technique for various studies using Arabidopsis seeds.
BRAAKSMA F. J. and W. J. FEENSTRA. Revertants of the nitrate reductaseless mutant B 15, II.
BRAAKSMA F. J., W. J. FEENSTRA and E. HERMANS. Nitrate reduction in Arabidopsis thaliana.
SCHOLTEN H. J. and W. J. FEENSTRA. Chlorate resistance of cell cultures of Arabidopsis thaliana.
GRESSHOFF P. M. Growth inhibition of Arabidopsis thaliana by glyphosate and its reversal by aromatic amino acids.
WINTERSOHL U., J. KRAUSE and K. NAPP-ZINN Phenyipropane derivatives in Arabidopsis thaliana (L.) Heynh.
YAKUBOWA M. M., Z. A. NAZAROVA and T. E. KRENDELEVA. Approach to the photochemical activity of chloroplasts extracted from leaves of Arabidopsis thaliana(L.) Heynh.
XUAN Le Thi and C. MENCZEL. Improved protoplast culture in Arabidopsis thaliana.
BEMCHENKO S. I. and T. B. AVRUTSKAYA. On the nature of the induced sterility of plants.
GRINIKH L. I., V. V. SHEVCHENKO and G. G. MIRZA ZADE (AKHUNDOVA). Induction of chimeric Arabidopsis thaliana plants in early embryogenesis.
SHEVECHENKO V. V., L. I. GRINIKH and G. G. MIRZA ZADE (AKHUNDOVA). Analysis of irradiation induced twinning in Arabidopsis thaliana.
ROFFER-TURNER M. and K. NAPP.-ZINN. Investigations on leaf structure in several genotypes of Arabidopsis thaliana (L.) Heynh.
USMANOV F. D. and G. A. STARTSEV. The appearance of stemfasciation in ,rabidopsis thaliana F2 by crossing the mutant 90 with lu'co (German with English summary).
KOORNNEF M. and J. G. VAN DER BEER. Centromere localization of chromosome 1 in Arabidopsis.
LAZANYI A. Increased plant *size,* heterosis and transgression, as consequences of induced geneduplications in Arabidopsis thaliana (L.) Heynh.
CHANG Audrey S. The effect of genotype by temperature interaction on genetic variability of flowering day in Arabidopsis.

C. Bibliography

New *references* on Arabidopsis Research.

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I VIL. TITLES OF ARTICLES PUBLISHED INTO PHYTOTRONIC NEWSLETTER

Editors Note. Many readers asked us to reproduce all titles of articles published into Phytotronic Newsletter from the beginning, we reproduce them here. Classified by Numeros.

N°1. November 1971. Controlled environments for plant growth (UK) -
Environmental requirements (B. Chandler)
- *Uses* on teaching (G. R. Sagar)
- Uses in research (R. B. Austin)
- Controlled environment for plant growth (G. N. Thorne)

N°2. May 1972.
Growth cabinets and growth chambers from different manufacturers: Germany, Belgium, Canada, France, United Kingdom, Japan, USA.

N°3. October 1972
Analysis of the symposium of Duke University (USA) (May 1972) with observations by Prof. R. O. Slatyer and Conclusions by Prof. P. J. Kramer .

N° 4, 5,6. November 1973
Strategy of Research at the Martonvasar Phytotron (Hungary) by S. Rajki.

N°7. May 1974
Plant culture under controlled atmospheres by R. Leroy (France).
New Pot Plant conveyor by J. A. C. Weir (UK).

N°8 October 1974
- Phytotronics. A New Strategy for Fundamental Research, Applied Research and Applications. Summary from Dr. P. Chouard's article.
- Phytotron in the Botanical Garden of Attila Jozsef (Hungary), for the Study of Ecological Role of Light. Dr. I. Horvath (Hungary)
- Use of the Phytotronic Method to Study Plant Growth at High Humidity, Dr. J. W. O'Leary (USA).
- Information and Control System for Farm Crop Cultivation Artificial, for Climate Stations (Phytotrons). Ir. B. M. Chetverukhin (USSR).

N° 9. February 1975
- ISHS Symposium. Greenhouse Design and Environment. Silsoe (Great Britain) September 1973
- Phytotronic Research. Comparison of plant growth in the field and in a phytotron Prof. P. J. Kramer *(USA).*
- Rice Physiology, Dr. B. S. Vergara (The Philippines).
- Phytotronics at the XII International Botanical Congress in Leningrad (USSR) July 1975. Requirements, uses and costs of Phytotrons. N. De Bilderling (France)
- Commercial application of sodium lighting for plant growth in the United Kingdom DrJ. A. C. Weir (UK).

N°10. June 1975
-Design and use of Phytotrons in Crop Productivity studies by CHM van Bevel and K. J. Mc Cree (USA).
-National Science Foundation project (RANN-USA) and Uniform watering of Potted plants. by prof. P. J. Kramer (USA).
The Wroclaw hydroponic cultures by Dr.2. Guninska (Poland)
- CO_2 Monitoring and control system for plant growth chambers and greenhouses by Dr. D.T. Petterson and Dr. J.L. Hite (USA).

N° 11. October 1975
-Southeastern Plant Environment Laboratories (SEPEL-USA) Prof. H. Hellmers - Phytotron at the Experimental Farm of the University of Pretoria (South AfricaDr. P. S. Hammes
-The Phytotron of the Oslo University (Norway) Stein Nilsen
-Experimental Research in Controlled Environments in Relation to the Perennial ***Grass*** Crop. Dr. G. J. A. Ryle et al. (UK)
-Root temperature Control in Phytotrons. Dr. G. I. Moss et al. (Australia) -Use of Growth Rooms in Cassava Research. Dr. L. A. Hunt et al. (Canada)
-Use of Controlled Environment Facilities as an Adjunct to Field Research on Potentially Tropic Adapted Grain Legumes. Dr. R. J. Summerfield et al. (UK) Soil Moisture Control for Phytotronic Studies. Dr. L. A. Spomer (USA)

N° 12-13. Avril 1976
Solar energy for greenhouse residence to be studied by Dr. D. Dalrymple (USA) -Taiwan Agricultural Research Centre (Republic of China)
-Small volume growth chamber and its control Dr. J. Krekule and all. Prague (Czechoslovak)
-Laboratory of Tropical Phytotechny. Dr. Ch. Renard Louvain (Belgium) -Photology. A New Branch in Forestry Science L. Roussel (France) -Polluted water Problems in Horticulture J. Wehrmann (FRG)
-The use of plastics for warmth insulation in Greenhouses P. Stickler (FRG) -Methods of productivity control of greenhouses cultures in the Far North G. S. Berson (USSR)
-The effects of CO_2 concentration and techniques of its control, on growth photorespiration and photosynthesis in chambers or phytotrons. Dr. Y. B. Samish (Israel)

-Use of classic growth cabinet in air conditioned box in a SO_2 atmosphere. Results obtained D. Pavlides (France).

N°14. November 1976

-Actual Research at the CNRS Phytotron in Gif/Yvette (France) Director : Professor P. Champagnat
-North Carolina State University Phytotron (USA) Annual Report 1975. Director : Doctor R. J. Downs
-Duke University Phytotron (USA). Annual Report 1975. Director Prof. E. Hellmers
-Some characteristics of Phytotron and greenhouse units at the Institute of Biology, University of Novi Sad (Yugoslavia). Prof:MlBaric
-Phytotron at Agriculture Canada's Research Station, Lethbridge Alberta Dr. A. M. Harper.
-The IRRI Phytotron (Phillipines) Dr. S. Yoshida
-Controlled Environment Rooms for Forest Trees . Rotolia.(New Zealand) R. J. Cameron and D. A. Rook
-Economics: Can Scientists succeed where Economists have failed? R. R. W. Folley (UK)
-Plasticulture and Research. NeW Objectives. Prof. A. Nisen (Belgium)
-Some thoughts on the potential use of Low grade Heat from Nuclear Reactors N. J. Beaton (Canada)
-Effect of CO_2 . Concentration on Morphological, Histological, Cytological and Physiological processes in tomato plants. Dr. E. Madsen (Denmark).
- Computer based data acquisition and process control for Phytotrons. R. L. Schafer and A. C. Bailey (USA)
- Controlled Environment Facilities for Rice Research. P. M. Singh and al. (USA and India)
-The use of Growth Chamber in Ecological Studies of the Climatic Control of Plant Distribution by Dr. F. I. Woodward (U. K.)
- Automated Liquid Culture System. A. S. H. S. Growth Chamber Committee Prof. T. W. Tibbitts (USA)

N°I5. May 1977

-Phytotrons in the Study of Plant Growth and Development. L. T. Evans (Australia) Optimization in Phytotrons. A. F. Klechnin and A. V. Malinovski (USSR) -Utilization of Phytotron for investigation of plant vitality. N. T. Nilovskaya and W. W. Laptev (USSR).
Automatic control of light intensity and spectral composition using small computer. T. Matsui and al. (Japan)
-The importance of a spatial structure for artificial lighting in Phytotrons. V. M. Leman and O. C. Fantalov (USSR)
Raising the photosynthetic productivity of plants as a result of the intensification of their root nutrition under out-door hydroponics. G. S. Davtyan (USSR).
Molecular basis of Photomorphogenesis. H. Mohr (G. F. R.)
Thermostability of cells and temperature conditions of species life. I. M. Kislyuk and al. (USSR)
-Change in organization and activity of photosynthetic apparatus during the first period after altered light intensity. G. D. Gubar and al. (USSR).
The effect of soil waterlogging on various physiological processes in maize. R. Brouwer (Netherlands).

N°16. August 1977

-Feedback control of leaf temperature T. Matsui and E. Eguchi (Japan)
Reactions of plants to long absence of light V. M. Leman and T. N. Chmanaeva (USSR)
Simulation of the plant stand production process. J. Ross (USSR)
-Equipment for measuring light inside the canopy in photosynthesis studies. P. Hari and al. (Finland)

-The potential productivity of plants and methods for revealing it B. C. Mochkov (USSR)
-Photosynthetic activity of tomato plants at different root system temperatures L. N. Chermnykh and al. (USSR)
-A study of the Kok effect on the Lactuca sativa cv. Romana A. Sarti and al. (Italy)
-The Kazakstan Phytotron F. A. Polimbetova (USSR)
-Conformational flexibility of protein molecules and adaptation of plants to the temperature of the environment. V. Ya Alexandrov (USSR)
-The use of numerical classification in the analysis of vegetation/environment relationshipa. P. F. M. Smartt and J. M. Lambert (UK)
-Some objective laws a gas exchange and productivity of phytocoenoses, N. T. Nilovskaya (USSR)

N°17. February 1978

-The use of airtight, daylit, controlled environment cabinets for fundamental and applied physiological studies of canopy photosynthesis. 3. Acock and all. (UK)
-A guarantee of Controlled environment parameters in Phytotrons. A. G. Anichkin and al. (USSR).
-Bioenergetic aspects of controlling agroecosystems productivity. r. I. Sventitski (USSR)
-On optimal radiation regime for plants in light cultures. A. O. Chuchalin and al. (USSR)
-The effect of the action of the spectrum and of light intensity in terms of the length of the photoperiod. F. I!'. F. Kuperman and al. (USSR)
-Competition for light : a physiological mechanism. N. B. Elliott and W. M. Elliott (USA)
-Photometers for Phytotrons V. S. Khazanov (USSR)
-Quantitative evaluation of energetic factors which limit plant productivity I. I. Sventitski and al. (USSR)
-The influence of environmental conditions on the parameters of circadian rhythms in plants. E. E. Krastina (USSR)
-Analysis of variance of dissimilarity coefficients as a tool for study vegetation environment relationship. V. I. Vasilevich (USSR)
-A dynamic model for crops growth rate in a dwarf shrub community. S. Kellomakii:. and al. (Finland).

N°18. October 1978

'Phytotron - North Carolina State University.1976, Annual Report
-Duke University Phytotron. Annual Report 1976
-K. A. Timiriazev Institute of Plant Physiology (Moscow USSR) Prof. B. P. Strogonov and Dr. V. I. Kefeli
Current plant biology research at Biotron University of Wisconsin (USA) T. T. Kozlowski
=The Plant growth rooms at the Department of Plant Husbandry. Uppsala (Sweden) U. Wunsche
-LIB Laboratory at **Essen** (F. R. G.)
The plant Gnotobiology Laboratory; description, procedures and uses, N. Hopkins and H. Hale (USA)
Controlled Environment facilities and their use at the Glasshouse Crops Research Institute/ Littlehampton,B. Acock and R. G. Hurd (UK)
-Revised Guidelines for reporting studies in Controlled Environment Chambers ASHS Special Committee on Growth Chambers Environments (USA)
Dynamic Modeling of Glasshouse climate and the application to glasshouse Control. G. P. A. Bot and al. (The Netherlands)
Differences in Response of plants grown under controlled conditions and in the field. J. E. Begg (Australia)
-Problem of growth analysis in controlled environments H. Krug (Germany FR)

-Potato Tuberization studies in controlled Environments. P. S. Eammes (Rep. South. Africa)
-Life History as related to weed control in the Northeast. N °8 Common Ragweed (USA)
-Hydraulic Architecture of Trees. Summary of Dr. M. A. Zimmermann conference (USA)
-Contaminants in plant growth chambers A. S. H. S. Growth Chamber Committee (USA)
-Simplifying the lamp changing schedule in Phytotron with_ the help of a computer programme R. C. Hardwick and D. J. Andrews (UK)

N°19 - February 1979

1977. CERES Annual Report
-Plant Physiology Division DSIR. 1978 Report
-Environmental control in Vegetable crop management : D. Rudd-Jones (UK)
Appendix to n°I9
-Introduction to the Symposium. James C. McFarlane
-Importance of Phytotronics in Horticulture. Gerald !toss
-Controlled Environments Lighting : High Pressure Discharge Lamp Based Systems Ion J. Warrington
-Reproducibility in Growth Chamber Research. P. Allen Hammer
-Standards for Measurement and Reporting. Theodore W. Tibbits and Richard R. Hodgson
-Environmental Stresses in Controlled Environments. Douglas P., Ormrod and Donald:T. Krizek
-Commercial Use of Controlled Environments,Robert W. Langhans and Hugh A. Poole
-A quality Assurance Program in Growth Chamber Research,James C. McFarlane -Uniformity Studies with Lettuce : Results of Growth and Tissue Analysis Wade L. Berry at al.
-A gradient Approach to Conducting Research on Plant Response to Radiant Energy. Gerald E. Carlson and Walter Giger Jr
-Plant Growth Under High Radiant Energy Flux Regimes in Controlled Environments (Abstract),I. J. Warrington
-A controlled Environment Room for Producing Advective White or Black Frost Conditions (Abstract) R. W. Robotham at al
-Horticultural Plant Responses to Atmospheric Pollutant §Abstract) D. P. Ormrod and G. Hofstra
-Concluding Remarks. I. J. Warrington (Co-chairman)

N°20. September 1979

-Report 1977. Phytotron NCSU (USA)
-Annual Report 1977. Division of Irrigation Research CSIRO (Australia)
-Controlled Environments working conference. D. T. Krizek (USA)
-IVT Phytotron 1953-1978. Plant breeding research under controlled conditions in horticultural crops (The Netherlands)
-Biotron. Manual for Investigators (USA)
-The determination of the total root length of a sample by an automatic methods F. H. Goubran and D. Richards (Australia)
-A note on expressing photosynthesis efficiency. C. J. Stigter (Tanzania) -Development of practical techniques for environment control for horticultural crops. G. X. Sproules (Australia)
Models in plant physiology an example in photoperiodism. F. Franquin (France) -Cabinets with climate environmental control for research on factors of plant growth,R. Leroy (France)
-theoretical and technical aspects of CO_2 enrichment of greenhouses atmosphere in tomato production. T. Wottaszek and al. (Poland)
-Morphogenesis of early lettuce under temporary direct cover of perforated plastic sheeting. F. Benoit and N. Ceustermans (Belgium)
-Daily Nitrogen metabolism in Capsicum annum. B. T. Steer (Australia)

VIII PHYTOTRONS ET INSTALLATIONS A ENVIRONNEMENTS CONTROLES

VIII-EXISTING PHYTOTRONS AND RESEARCH INSTITUTE WITH ENVIRONMENT CONTROLLED INSTALLATIONS

Note des editeurs. A la suite de nombreuses demandes le Secrdtariat Phytotronique a lance une enquete auprds des Phytotrons et Instituts de Recherches disposant d'environnements controles. Nous donnons ci-dessous les rdsultats de cette enquete avec quelques adresses complementaires.

Les lecteurs francophones voudront bien nous excuser du texte anglais de cette enouete, eels nous avons voulu conserve la langue utilisde dans les reponses, pour dviter toute erreur de traduction.

Editor's Note. Many readers would be interested about existing Phytotrons or Research Institutes utilizing environmental controlled installations, specially addresses and general lines of research. We present following, (by alphabetic list of nations) receiving informations to which we add several complementary addresses. Except Belgium, France and Switzerland all informations are in English.

_Australia

a. Canberra Phytotrons (CERES) CSIRO Division of plant industry PO Box 1600 Canberra City ACT 2601 Australia

-Chief of division : Dr. W. J. PEACOK
-Officer in Charge of CERES: Dr. Ian F. WARDLAW -Approximately SO researchers in any one year -Reception of foreign researchers, mainly through contact with Individual Scientists
in the Division of plant Industry.
-General lines of research. Wide ranging agronomic, ecological and basic plant research covering aspects of photosynthesis, nitrogen fixation, plant and soil nutrition, natural and synthetic growth regulators, environmental control of plant growth and development, crop adaptation, genetics, plant pathology, the ecology of weeds and native plants, taxonomy, and studies on crop and grazing management systems.

b. CSIRO Division of irrigation research. Private Mail Bag Griffith New South Wales 2680 Australia

-Director : Dr. P. E. KRIEDEMANN
-16 researches: Reception of foreign researchers
-General lines of research. Water management for efficient irrigation, development of ecologically sound methods for waste-water utilization, alleviation of root-zone problems associated with rising saline ground water, studies of irrigated crop nutrition with particular emphasis on nitrogen utilization, breeding of oilseed crops and development of energy saving methods for greenhouse cropping.

Austria

Klimahaus der Forstlichen Bundesversuchsanstalt Rennweg 1 A 6020 Innsbruck Austria

-Director : Prof. Dr. W. TRANOUILLINI
-4 researchers. Reception of foreing researchers without payment
-General lines of research. Experiments with forest plants: gas exchange in controlled environment, shoot and root growth in growth chambers, frost and drought resistance.

Belgium

a. Universtte de Liege, Departement de Botanique, Bat.1322, Sart 7¯limn B 4000 Liege Belgique

-Directeur : Prof. G. BERNIER
-Responsable du Phytotron A. PARMENTIER
-7 chercheurs . Reception de quelques chercheurs strangers
-Objet des travaux de recherche: physiologie de la floraison et de la fructification.

b. Centre National d'Etude des Cultures Fruitieres (CNECF) 2 Av. de la Faculte d'Agronomie. 5800 Gembloux Belgique

Equipement phytotronique specialise

Canada

Canada Agriculture Research Station. Lethbridge,Alberta/T1J 4B1 Canada

-Director: Dr. J. E. ANDREWS
-Chairman of Phytotron committee: Dr. A. M. HARPER
-69 researchers in march 1980. Reception of foreign researchers
General lines of research. Crop entomology. Soils. Plant Science. Plant Pathology. Plant physiology. Plant Breeding, Low temperatures plant studies. Animal Science. Animal parasitology

China

Shanghai Institute of Plant Physiology, Academia Sinica 300 Fonglin Road,Shanghai, China 20032

-Director: Prof. H. C. YIN
-Heads of the Phytotron: Dr. WANG-HUNG-CHUEN
-38 researchers : No receiving foreign researchers
-General lines of research: Water relation of plants. Chilling injury of plants. Air pollution of plants. Growth and development of plants.

France

a. Phytotron. C. N. R. S. 91190-Gif/Yvette. France

-Directeur : Dr. R. JACQUES
Recherches : Physiologie phytotronique. Organogenese. Induction photoperiodique. Phytochrome. Metabolisme physiologique

b. Station d'Amelioration des plantes fourrageres . INRA 86600 Lusignan {France)

Directeur: P. MANSAT
Equipement phytotronique de circonstance. Responsable C. POISSON.

c. Station de Physiopathologie. INRA BV 1540. 21034 Dijon France

-Directeur: Dr. Cl. MARTIN
Recherches: Virologie fondamentale. Differentiation cellulaire. Biochimie de la reproduction. Mode d'action des herbicides

d. Laboratoire de Physiologie vegetale.4,6 rue Ledru. 63000 Clermont (errand

Directeur: Prof. P. CHAMPAGNAT
Recherches: Rythmes. Microbiologie. Tuberisation. Physiologie des vegetaux ligneux. Phytomorphogenese.

Germany F. R. G.

a. J. Liebig. UniversitatGiesseh. Institut fur Pflanzenbau und Pflanzenzuchtung. Phytotron Ranischholzhausen. 0.3557. Ebsdorfergrund 4.

-Director: Or. B. BRETSCHNEIDER-HERRMANN
-2 researchers. No receiving foreign researchers
-General lines of research: Response of growth, development yield and quality factors of cultivated plants and their varieties on climatic factors, mainly temperature and daylength. Optimizatieh of climatic conditions for maximum yield, Cultivation of plants and seed production in early stages of breeding.

b. Landesanstalt fUr Immissionsschutz des Landes Nordrhein Westfalen Wallneyer Strasse 5 4300 Essen

-Director: Prof. Dr. H. STRATMANN
-Responsible of the Phytotron; Dr. PRINZ
-7 researchers. No receiving foreign researchers
-General lines of research: Research of effects of environmental stresses on plants under various pollutants and concentrations. Studies of deleterious effects of air pollutants to materials like stone, metal etc..

c. Albert-Ludwigs-Universitat.3iologisches Institut II Schanzlestrasse I. D.7800 Freiburg im Breisgau

-Director: Prof. H. MOHR
-Responsible of the Phytotron: Dr. W. THIEN
-15 researchers: Receiving foreign researchers only for long term appointments -General lines of research. Control of development by phytochrome in green plants. Interaction of the blue/UV photoreceptor and phytochrome in controlling plant development.

d. Institute fur Gemmsebau der Universitet Hannover-Herrenhauser Str.2. D. 3000 Hannover 21

-Director: Prof. Dr. R. KRUG. Prof. Dr. H. J. WIEBE
-8 researchers: Receiving foreign researchers
-General lines of research. Vegetable crops-vernalization/photoperiodism, photosynthesis and respiration, reactions to temperature and radiation levels and rhythms, waterpotentail, CO2, Ca-deficiency.

e. Biol. Forschung Bayer A. G. D.5090 Leverkusen

-Director: Dr. Helmut TIELZ
-12 researchers. No foreign researchers
-General lines of research. Production and control of pesticides

f. Institut fur Pflanzenbau und Pflanzenzuchtung Federal Research Center of Agriculture Braunschweig. Volkenrode (FAL) Bundesallee 50. D.3300 Braunschweig

-Director: Prof. Dr. M. DAMBROTr
-Responsible of the Phytotron: Dr. Cl. SOMMEP
-11 researchers: Receiving foreign researchers
-General lines of research: Eco-physiology of agriculturally used cultural plants whereat, besides of questions concerning metabolism and yield physiology, especially the possibilities of including these results into the selection process of plant breeding are interesting, in order to improve the harvest index of plants and to increase the efficiency of the employed means of production.

g. Lehrstuhl fur Gemusebau der Techn. Universitat Munchen. D 8050 Freising-Weihenstephan bei Freising/Obb. Fed,Republic of Germany

-Director: Prof. Dr. D. FRITZ
-6 researchers. No foreign researchers
-General lines of research: Nutrient uptake under controlled climatic conditions. Photoperiodical treatment of medicinal and spice plants. Clonal propagation and san production of medicinal plants.

Hungary

Agricultural Research Institute of the Hungarian Academy of Sciences. Phytotron H 2462 Martonvasar Hungary

-Director: S. RAJKI
-Engineer for maintenance: T. TISCHNER
-Responsible for plant raising: E. RAJKI
-Approximately 10 researchers
-Reception for foreign researchers, on the basis of agreements.
-General lines of research; wheat breeding: raising several generations of winter wheat a year, production of complex hybrid, frost resistance testing etc. Automnisation research. Flowering biology, aneuploid genetics etc. Studies on the seeding of Kohlrabi testing of antidotes to maize herbicides. Phytotronics development: homogeneous optimation.

Israel

a. The Hebrew University of Jerusalem. Department of Agricultural Botany POB 12 Rehovot 76-100 Israel

-Director: Prof. D. KOLLER
-Responsable of the Phytotron: Dr. M,OFIR
-20 researchers. Reception foreign researchers
-General lines of research. Environmental control of flowering, dormancy in buds and in seeds, morphogenesis, vegetative development. Environmental stress physiology Nitrogen fixation in the rhizosphere of grasses.

b. Desert Research Institute. Ben GUrion University of the Negev. Sede Boger Campus POB 2053 Beersheva 84120 Israel

-Director: Prof. A. RICHMOND
-Responsable to research: Prof. J. GALE
-Approximately 20 researchers Reception foreign researchers
-General lines of research. Development of controlled Environment Agriculture for Hot Desert Regions, includes aspects of engineering, mathematical simulation modelling. plant physiology, hydroponics and economics.

Japan

a. Institute for Agricultural Research. Tohoku University 2-1-1 Katahira Sendai Japan

-Director: Dr. M. KANDP
-Officer in charge of Phytotron: Dr. N. TAKAHASH:
-40 researchers. Reception of foreign researchers
-General lines of research. Photomorphogenesis. Interaction between gene expression and environments. Ecological distribution of cultivated and wild plants. Environmental stress to plant growth.

b. Biotron Institute. Kyushu University. Fukuoka 812 Japan

-Director; Prof:T. MATSUI
- 5 researchers: Reception of foreign researchers
-General lines of research: Biotronics. Studies on control of physical environments, analysis and environmental control of biological responses

c. Hokkaido Agricultural Experiment Station Hitsujigaoka. Sapporo Japan

The Netherlands

a. Centre for Agrobiological Research. POB 14 Bornsesteeg 65-67 Wageningen 6700 AA The Netherlands

-Director: Dr. P. GAASTRA . Deputy director:Dr. J. H. J. SPIERTZ
-Responsible of the Phytotron: Dr. J. H. J. SPIERTZ and Dr. H. CHALLA
-40 researchers, approximately 15 carry out experiments under controlled environment conditions. Foreign researchers acceptable
-General lines of research: Photosynthesis and respiration of various crops. Stomata behaviour and transpiration of C3 and C4 plants. Root growth and activity at various temperatures. Research on N-assimilation and N-fixation,

b. Institute for Horticultural Plant Breeding (IVT) Manhsoltlaan 15. POB 16.6700 AA Wageningen (The Netherlands)

-Director: Ir. C. DORSMAN
-Responsible of the Phytotron: Dr. L. SMEETS
-23 researchers. Foreign researchers acceptable
-General lines of research. Plant breeding research with vegetables, fruits, flowers, bulbs, woody ornamentals.

c. Agricultural University. Dept. Of Horticulture. Haagsteeg 3 POBox 30 Wageningen The Netherlands

-Director's name:Prof. Dr. J. DOORENBOS
-7 researchers. Receiving visits
-Limited possibilities for prolonged stay of foreign researchers and no funds for living expenses (etc) available
-General lines of research: growth and development of horticultural plants

d. IMAG. Institute of Agricultural Engineering. Mdnilholtlaan 10-12,Postbus 43 6700 A. A. Wageningen The Netherlands

-Director: Jr. F. COOLMAN
-Responsable Climate Control division Ir. W. P MULDER
-250 researchers. Foreign researchers limited
-General lines of research in the Division: Energy saving and climate control in greenhouses

New Zealand

a. Forest Research Institute. Private Bag ROTORUA. New Zealand

-Director: Dr. C. BASSET
Responsable of Phytotron: Dr. D. A. ROOK
-130 researchers in the Institute and 5 in the Phytotron. Foreign researchers acceptable
-General lines of research: Effect of environmental factors on seedling and tree growth . Rooms will contain trees 7m. Tall,

b. Climate Laboratory. Plant Physiology Division. DSIR Private Bag. Palmerston North New Zealand

-Director: Dr. J. P. KERR
-Responsible for climate laboratory: Biological; Mr. I. J. WARRINGTON. Technical; Mr. R. W. ROBOTHAM
-32 scientists, 22 science technicians. Total 60. Foreign researchers acceptable. -General lines of research: The Climate Laboratory carries out environmental research primarily on agricultural, horticultural and forestry species for scientists throughout New Zealand. Plant Physiology Division has scientists engaged in research work in biochemistry, tissue culture, whole plant and crop physiology, agricultural physics and agronomy.

Norway

Department of Floriculture and greenhouse crops. Agricultural University Norway N 1432 Aas NLH

-Director: Prof. E. STROMME
-Responsible of Phytotron: Dr. R. MOE
-6-8 researchers. Foreign researchers acceptable'
-General lines of research: The study of environmental factors on growth and development of greenhouse crops.

Philippimes

The International Rice Research Institute. PO Box g33. Manilla Philippines
All problems with rice selection and cultivation.

Poland

a. Laboratory of Phytotron. Agricultural Academy ul. Podluzna 3.30-239 Krakow Poland

-Director: Prof. Dr. A. MARKOWSKI
-12 researchers; Acceptable 1-2 researchers after prior consultation,
-General lines of research: Physiological mechanism of the processes of vernalizatiob and photoperiodism. Physiological bases of winter hardiness in plants. Physiological indexes of crop plants productivity.

b. Research Institute of Vegetable Crops . u1.22 Lipca 1/3 96-100 Skierniewice. Poland

-Director: Prof. Dr. Z. GERTYCH
-Responsible of the Phytotron:Prof. Dr. L. S. JANKIEWICZ
-9 researchers in the department of Biology. Foreign researchers ac. CepGa.. G..
-General lines of research:The influence of environment on Vegetable Crops, their morphogenesis, structure and ultrastructure (in transmission electron microscope). Tissue cultures. Application in breeding and plant protection,

Republic of South Africa

Phytotron Unit. Faculty of Agriculture. University of Natal. P0 Box 375. Pietermarizburg 3200 Republic of S. Africa

-Director: Prof. M. M. MARTIN . Dept of microbiology and plant pathology -2-4 researchers. Foreign researchers no receiving.
-General lines of research: The facilities with control of most variables will be achieved in 1980. Uses include Horticulture, Crops, Plant Pathology.

South Corea

- Crop Experiment Station. Office of Rural Development. Suwon-South Corea

Sweden

a. The Swedish seed Association. SVALOFAB
S.26800 Svalov Sweden

-Director:G. KUYLENSTJERNA
-Responsible of the Phytotron: Dr. V. STOY
-4 researchers. Foreign researchers accepting occasionally
-General lines of research: The chambers are used for crop physiological research in connection with practical plant breending work. Main crops are cereals and oil rape sometimes potatoes and grasses. Particular fields of research are grain formation in cereals and physiology of stress (water, temperature)

b. Department of Plant Husbandry. Agricultural College. Uppsala 7 Sweden

c. Royal College of Forestry. S10405 Stockholm 50 Sweden

Switzerland

Station federale de recherches agronomiques de Changins (RAC) CH 1250 Nyon-Suisse

-Directeur: Ir. M. ROCHAIX
-55 chercheurs. 5 stages non retribues possible
-Travaux de recherches: culture de tissus i travaux de genetique, de selection, . De phytopathologie at de physiologie

Taiwan

AVROC. PO Box 42. Shankua. Taiwan 741

United Kingdom

Glasshouse Crops Research Institute. Worthing Road Rustington. Littlehampton.
Sussex BN16 3PU England

-Director: Or. D. RUDO-JONES
-Responsible of the Phytotron: Dr. K. E.
COCKSHULL -90 researchers. Foreign researchers
acceptable
-General lines of research: Scientific research bearing on the cultivation of glasshouse crops and mushrooms, and of bulbs, flowers and shrubs grown in the open. The research is grouped under three headings, namely: Physiology and Chemistry, Crop Protection and Microbiology and Crop Science_

United States of America

a. North Carolina State University. SEPEL. 2003 Gardner Hall. Raleigh NC 27650 USA

-Director: Dr. R. J.OOWNS
-Approximately 25 researchers use the NCSU Phytotron at any given time. Foreign researchers acceptable
-General lines of research: all aspects of environmental physiology.

b. Duke University Phytotron. 139 Biological Science Bldg. Durham NC 27706 USA

-Director: Dr. B. R. STRAIN
-Responsible of the Phytotron; Mr. N. McQUAY
-10-15 researchers. Foreign researchers acceptable.
-General lines of research: Environmental physiology, carbon dioxide exchange, plant water relations crop improvement, stress physiology, weed ecology genecology, effects of CO2 enrichment.

c. The Biotron. 2115 Observatory Drive. Madison Wisc.53706 USA

-Director: Dr. T. T. KOZLOWSKI
-15 to 50 researchers usually. Foreign researchers acceptable.
-General lines of research: A wide spectrum of controlled environment research with both plants and animals. The Biotron provides control of temperature, radiation, daylength, humidity, wind, high and low pressures, pollutions and sound. The Biotron can also program diurnal and seasonal variations in environmental parameters.

d. Department of Plant Physiology HSPA Experiment Station 1527 Keeaumoku Str. Honolulu Hawai 96822 USA,

USSR

a. All Union Institut for genetic and selection. Ovidiopolsky way n°3.Odessa 270036 USSR

-Director: L. K. SETCHNIAK
-60 researchers
-Reception foreign visitor's official address of Agriculture Ministry. Optimal time december till april.
-General lines of research. Fundamental and applied selection and genetic problemS' of cereals.

b. Institute plant Physiology. Acad. Science. 33 Botanitcheskaya Str.127273 Moscow USSR

Fundamental research of all plant physiological problems.

c. Institute of Physiology Acad. Science. PO Box 1243. Irkoutsk 664033 USSR,

d. Mironovsky Wheat Institute. Mironovka. Region of Kiev. USSR.

Selection of cereals
e. All union Rice Institute. P. O. Belozeroe Krasnodarskii Kzaj. 353.204 USSR

Selection and breeding on rice

f. Soil Institute Phytotron. KorpusL Moscow. University 117234 Moscow (USSR)

Yugoslavia

Faculty of Sciences, Institute of Biology . I. Ojuricica.21000 Novi-Sad.6. Yugoslavia

-Director: Dr. D. STEVANOVIC
-Responsible of the Phytotron: Prof. Dr. M. R. SARIC
-4 researchers. Foreign researchers acceptable
-General lines of research: Problems of plant physiology: the effect of light of different wavelengths on plants, especially on the photosynthesis, as well as the effect of biotic and abiotic factors on the element content of mineral nutrition.

IX. PHYTOTRON IN SHANGHAI INSTITUTE OF PLANT PHYSIOLOGY ACADEMIA SINICA

Editor's Note. Professor P. J. Kramer (Duke University , Dept. Of Botany, Durham N. C. 27706-USA) have sent us recently letter and with some indications about Shanghai Phytotron. We reproduce above theseinformations which are probably interested for **our** readers.

1) Extracts from P. J. Kramer's letter:

"In late september and october **I** spent nearly a month in China as a guest of their Academy of Forestry. Among the laboratotes visite4was that of the Institute of Plant Physiology of Academia Sinica at Shanghai. It has considerable modern equipment and an energetic staff which *is* well informed concerning western science.

"Of most interest to me was their phytotron which I have never seen described in the western part of the world. I enclose a brief description of the structure and a List of some of the research in progress.

"Dr. Hung-chung Wang is in charge of the phytotron and Dr. H. C. Yin is Director of the Institute of Plant Physiology which operates it. They probably would provide more information if you desire it.

"I had some questions concerning their design, especially lack of separate cooling for their lamps. Nevertheless, I consider the construction of this phytotron to have been a remarkable achievenent (builc it in 1969).

2) Phytotron in Shanghai Institute of Plant Physiology Academia Sinica

The phytotron in the Shanghai Institute of Plant Physiology of Academia Sinica was built in 1969. It was designed and constructed entirely with local resources. It has a total working space of 380 m2, consisting of by chambers (15, 10 and 6 m2 each, totaling, 253 m2) with artificial illumination and 6 glass chambers (24, 15, 12 or 6 m2) under natural light. Air ***is*** preconditioned separately below, enters through the floor and leaves above the growing space.

Temperature can be set from 5 to 50,t + **l**°. and relative humidity at 30-95% + 7% in the artificially lighted rooms, illumination is provided by specially made xenon lamps cooled by circulating water and can reach up to 310.000 lux. The green house chambers, temperature can be ***set*** at 0º to 30˚C +/-2C and relative humidity at 60-80 + 10%

In addition, there are 2 cold roams of 10 m2 each at -10C and -20C. Several removable reach in chambers have also been installed for air pollution work.

Research work in progress in the phytotron:

1. Photo and Thermo sensitivities of different varieties of rice (S. H. Tang)
2. High Temperature injuries of rice (H. C. Wang)
3. Photoperiodism of sugar beet varieties (S. C. Jen)
4. Mechanism of action of air pollutants (S. W. Yu)
5. Drought resistance of plants (W. L. Wang)
6. Genetic behaviour of photoperiodic response of rice (S. H. Taing)
7. Minor elements physiology of plants (C. S. Nie)
8. Accumulation and transport of plant photosynthates.

The phytotron is also used to grow special plant materials for research of the other departments of the institute. It is also open to other institutions aside form plant research by special arrangement.

XP AT THE C. N. R. S. PHYTOTRON IN GIF

R. JACQUES Director

The Phytotron Laboratory, founded in 1957, has, during the past 20 years, organized numerous research group, each of which has focused its activity on a special area of plant physiology. The various aspects of this physiology, however, are always studied in relation to several environmental factors and. in particular, light, temperature, mineral nutrition, water, gaseous composition of the atmosphere etc.

Throughout the years, study techniques have had to evolve according to advances in research programs. During this period of adaptation, the Phytotron has often pl ayed a primordial role within the scientific community. *As* an example, we can recall the work done on photomorphogenesis and chronobiology, on adaptation to dryness and salinity on a study of photosynthetic and respiratory balance sheets, and on atmospheric pollution. For all this research, special culture techniques were created or adapted obtaining very high luminous or monochromatic levels, the development of experimental systems for measurements with the entire plant over a tong period (balance sheets of water. CO_2 SO2 pollution ..). At the same time the use of biochemical techniques on the laboratory level, became generalized by a progressive acquisition of the indispensable apparatus.

Currently, about 50 researchers are working permanently in the laboratory, in collaboration with 70 other persons (engineers, technicians and administrative personnel). In addition to these teams of permanent researchers, about 30 programs are carried out in the Phytotron, belonging to researchers working elsewhere (Researchers in universities, in other C. N. R. S. laboratories, in Agronomic Research or in other public and private centers). These programs are examined by an appropriate scientific committee - the "Welcoming Committee",

Thus, in 1980 after 20 *years* of existence, the Phytotron is completely functional and given the excellent state of maintenance of its technical installations, it can be of great use for contributing new knowledge concerning plant behavior in terms of its environment.

The breadth of research carried out in the laboratory is quite large. Only some of the aspects of research are briefly exposed below.

Readers desiring more information or reprints can directly contact the Heads of the Research Groups at following address

Laboratoire du PHYTOTRON- C. N. R. S - 91190 GIF SUR YVETTE (FRANCE)

IN VITRO MORPHOGENESIS

(TRAN THANH VAN and TRINH T. TOAN HANH)

Our group study the "mechanism" of the control of rnorphogenisis in some plant species. This study is made on entire plants and experimental systems which was conceived specially to represent an intermediary between entire plants on the one hand,and isoleted cells and protoplasts on the other hand. This system is composed only of a single layer of cells, or 3 to 6 layers of differentiated cells, epidermic and sub-epidermic cells, ie. cells having already expressed th2it differentiation programme, imposed during ontogenic processes. These experimental systems devised in our laboratory are called "thin cell layers".

2 This study is based on a physiological, morphological analysis of programing of the morphogenetic patterns which can be found on the entire plant :

(1) direct induction of flowers.
(ii) direct induction of roots.
and (iii) direct induction of shoots.

Of these three programmes, one can add another : induction of cellular divisions leading to the formation of a callus of continue growth without subsequent organo-gene sis

3 The different programs are obtained <u>in vitro</u> by varing several parameters chosen, due to their important impact on the diviation from one morphogenetic type to another type

These parameters studies are as follows :

(I) Culture medium

I - Chemical composition of culture medium (macro-micro elements, carbohydrates, phytohormones and analogues).
II - Its pF.,
III- Its hydrique potentiel.

(2) Composition of the atmospheric gas in contact with *the* explant.

(3) Influence of light (quantityandquality).

(4) Influence of temperature.

To these parameters which are exogenously applied to the explant, one should consider adding other parameters which characterise the past of the explant ; i e the genomic characteristic of the donor plant and its biochemical physiological state at the moment of excision of the explant.

4 -These programes, once controled are the analysed at the following levels :

I - Cellular, (cytological, infrastructural)
I I - and biochemical (enzyme, protein, glycoprotehland its conjugates, carbohydrates, polyamines and its conjugates, nuclei acids etc...)
III - and biophysical (membrane permeability as a function of the precise parameters, mentioned in 3 levels).

A certain number of laboratories in France, Europe and overseas are participating in the development of this programme according to their own specials fields.

5 This study at the fundamental level has given interesting applicable re suts : for example considering the species considered difficult to regenerate organs, the fact that the use of this cell layers instead of the conventional stem fragments has allowed us to initiate direct bud formation, direct root formation or callus. These organogenetic potentialities masked in organ fragments are revealed in thin cell layer where intertissus correlation has been changed.

6 - The group has studied some species of Rosaceae, Orchidaceae, Solanaceae, Gesneriaceae, CrUciferae, and Apocynaceae.

The results obtained have allowed us to extend the control of organegenesis (to a certain degree) to more recalcitrant species (in the point of view of in vitro organegenesis) ***such*** as the legumes (Psophocarpus, Glycine, Vicia, Lens .) and certain economically important woody plant such as conifers or ochraeia.

7 In conclusion, thin cell layer methodology has permitted us to devise an experimental system which is simplified enough to be homogenous and which is sensitive to exogenously applied factors However the cell-to-cell contact is maintained to allow this system to programme all morphogenetic patterns known on an entire plant. Further more, this simplified system known on an entire plant, was shown to be able to express new morphogenetic patterns, such as unicellular hairsformation from epidermal cells of leaves or new patternsof meristems mhich are not vegetative, nor floral.

REFERENCES

TRAN Thanh Van, M. 1973a. In vitro control of de novo flower, bud, root and callus differentiation from excised epidermal tissues. Nature, 246, 44-45.

TRAN Thanh Van, M. 1973b. Direct flower formation from superficial tissue of small explants of Nicotiana tabacum L. Planta, 115, 87-92.

THAN Thanh Van, M. 1977. Regulation of morphogenesis. In "Plant tissue culture and its bio-technological application" (W. Barz, E, Reinhard and M. H. Zenk, eds.), pp. 367-385. Springer-Verlag, Berlin, Heidelberg, New York.

TRAN Thanh Van, M. 1978. La floraison et les probleraes qu'elle pose. Encyclopedia Universalis

TRAN Thanh Van, M. 1980. Control of morphogenesis by endogenous factors and exogenously applied factors. Academic Press

TRAN Thanh Van, M. 1980. What shapes a group of cells in plant tissue culture ? Springer-Verlag

B. FLOWERING PROCESS, PHOTOPERIODISM AND CORRELATIONS

(J. EIRULFERT et E. MIGINIAC)

Anagall is arvensis is an absolute long-day plant which requires only one long day far flowering (TT. This threshold inducing effect can determine the production of either normal complete fl owers, or flowers presenting partial leaf -like structures ("proliferous flowers") . The existence of these intermediary morphogenetic responses and the quantitative development of flowering, depending on the intensity and duration of the photoperiodic treatment suggest that, in the plant, the photoperiodic "trigger' of a "flowering program" could be modulated by several types of factors:

- environmental parameters: temperature, light intensity, photoperiod...
- endogenous factors: the axils of the youngest leaf primordia (where flowering occurs) show a differential sensitivity to the 'floral stimulus" depending on their

ageing; in threshold inductive conditions the response of the plant can be greatly affected by the actual developmental stage of the expression sites where flowering normally takes place (2).

Such a modulation of the photoperiodic effect has been also shown in the Scrofularia arguta and Chenopodium polyspermum where:

- the flowering occurs spontaneously (without any photoperiodic induction) only if the buds are isolated from correlative influences (3, 4).

- the flowering is inhibited by the roots as in Anagallis arvensis the inductive effect of the flowering is suppressed when the single long day occurs simultaneously with a given step of root development (5).

Cytokinin treatments inhibit the flowering of these 3 plants, whatever is the mean of induction : suppression of the roots in Scrofularia arguta and Chenopodium polyspermum or application of one long day in Anagallis arvensis. In this last case, the Tiing of the hormonal treatment must fit with the inductive period.

Others organs than the roots can play an important role in the regulation of the flowering (for instance in Scrofularia arguta, the terminal bud or the auxin which it produces, antagonizes the root action and a young leaf stimulates the vegetative development of the bud located at it axill, but only if the plant is rooted). The development of a bud is the resultant of a complex system of inter-organic correlations which corresponds to a pluri-factorial regulation. Numerous substances, like known plant hormones, act on the flowering.

Results from this kind of experimentation can direct the work realized to understand how a photoperiodic treatment induces the flowering. For example, at present, the researchs try to evaluate the diverse forms of cytokinins in Chenopodium plants, induced or not. In the same way, thermic treatments of the roots, modifying the root-shoot relationships and, essentially, limiting the growth of the roots, stimulate the flowering, diminishing the photoperiodic requirements of this plant. Work in progress describes the physiological modifications of this treatment: hydric equilibrium, mineral nutrition, hormonal balance.

The substances which act on the flowering are produced preferentially in different organs of the plant. Their transport to the meristems is an important step of the complex mechanism of flowering. So, the modalities of IAA transport inside Scrofularia arguta plants have been studied and have shown that the axillary buds were not reached by the tracers. Therefore the hormone has an indirect morphogenetic role. IAA migrates preferentially in the phloem tissue and its level of metabolization is higher when its course inside the plant is longer. In the same way, the sucrose transport in Scrofularia arguta plants is highly a function of the organization of the plant (suppression of some organs) and of the hormonal treatments (auxin gives to the treated tissues the ability to attract the metabolites circulating inside the plant).

Finally, very fast movements of diverse metabolites and of auxin, probably depending only on physical mechanisms, have been shown in Scrofularia arguta.

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I. BRULFERT J., IMHOFF C., FONTAINE D. T976. Etude comparative de d'induction photopériodique aux niveaux morphogenetique et metabolique. In " Etudes de Biologie veg6tale". Hommage au Professeur P. CHOUARD. R. Jacques Ed. Paris, 443-455.

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3. MIGINIAC E. 1978. Some aspects of regulation of flowering in photoperiodic plants. In "Controlling factors in plant development". Bot. Mag. Tokyo 1, 159-173.

4. SOTTA B. 1978. Interaction du photoperiodisme et des effets de la zeatine, du saccharose et de l'eau dans la floraison du Chenopodium polyspermum. Physiol. Plant. 43, 337-342.

5. BISMUTH F., BRULFERT J., MIGINIAC E. 1979. Mise a fleurs de l'Anagallis arvensis L. en cours de rhizogendse. Physiol. Veg. 17, 477-482.

6. MIGINIAC E. SOSSOUNTZOV L., DUGUE N. 1978. Modalites du transport et du mdtabolisme de l'AIA-[14]C ou de l'AIA.[3]H en relation avec la morphogenese des bourgeons axillaires chez le Scrofularia arguta. Physiol. Plant., 44, 335-344.

C.-EFFECT OF PHOTOPERIOD ON CARBON BALANCE AND CO2 EXCHANGES IN PLANTS

(M. MOUSSEAU)

The research area concerns experimental analysis of the influence of climatic factors on elementary processes of primary production studied by mean of gas exchange measurements and precise control of environmental conditions. During the recent years we developped a study of the action of different photoperiods on CO_2 exchanges to find a possible link between the results and plant development.

Daily CO_2 exchanges have been followed on Sinapis alba L., grown in short or long day conditions. For the CO_2 measurements, three types of experimental conditions have been used, differing in the level and duration of daylight.

The shape of the night respiration curve is affected by the previous photoperiodic regime, while the shape of daily apparent photosynthesis is not. There is a beneficial effect of lengthening the light period for the same daily energy amount on CO_2 balarce, specially on the short day grown plant (1).

In all daylengths, for long and short day grown plants, there is a significant correlation between CO_2 gain in the light and loss in the dark. The results suggest that this dependence may be different in short and long day plants (2).

Then a preferential short day plant, Chenopodium polyspermum L.,has been grown under short or long day conditions: in each case, the plants received daily the same amount of energy (9h); night period was given either by darkness or by dim red or far red radiations.

The different growth conditions induced large variations in the development of the plant, particularly in dry matter distribution (3).

No significant differences were found in photosynthetic activity in connection to the observed differences in the development. However different time patterns of night CO_2 output were found depending on the photoperiodic regime. Red light, acting through phytochrome, appeared to be responsible for the presence and timing of an increase of CO_2 output at the end of the night (4). This peak of CO_2 production also developed progressively under long night conditions conductive to flower formation (2).

REFERENCES

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D. PHOTORESPIRATION

(G CORNIC)

The functioning of photorespiration in plants C $_3$in "normal" conditions (temperature, 25°C, CO_2 concentration, 300 ppm) brings about a considerable loss of energy. The negative aspect of this process for plant production, stressed on numerous occasions was used as a starting point for all the combination of the work research taken together that has been done by physiologists, biochemists and geneticists : would it be possible to improve production by decreasing photo-respiratory intensity by specific chemical means, or by selecting mutants where the intensity of this phenirmenon was low ?

The results of this research was disappointing in this respect. However, the idea that photorespiration could be of any use to plants progressively emerger from to us litterature data: We would like to suggest the following hypothesis : photorespiration may play a role in the working functioning of the photosynthetic apparatus when a plant is submitted to extreme environmental conditions Over the past three years. we have tested this hypothesis by examining the long term and short term effect of oxygen - whose role in photorespiration is well known - on photosynthetic activity measured under different conditions. The following results were obtained.

1 - A short inhibition of photorespiration obtained by placing a plant in an atmosphere of low O2 and CO_2 content was found to cause great charges in the photosynthetic activit**y** subsequently measured under normal conditions. Photosynthetic activity was strongly inhibited as well as the activity of Hill measured under limiting and saturating energy. Photorespiration may well have a role in the photosynthetic apparatus . particularly in plants submitted to a temporary hydric stress. In this case, indeed the stomatal closure give rise to a decrease in CO_2 concentration in the intercellular spaces in leaves . (1)

2 - Under certain conditions - low temperatures (from 5 to 10°C), high light intensities - atmospheric oxygen can stimulate the intensity of the apparent photosynthesis. In these conditions, it can be shown that luminous energy is used more efficiently by yhe photosynthetic apparatus. (2) We think that photorespiration taking place at low temperatures may be responsible for the observed effect.

Both observations, briefly described, are being studied thorouhgly.

Metabolic studies will probably show if as we think, photorespiration involved in the two phenomenon that were described.

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E .—DROUGHT RESISTANCE

(C. HUBAC)

Drought produces morphological and biochemical modifications. We compare genetic resistant plants or sensible plants, with plants made more resistant by environmental factors, as photoperiod or fresh temperature on roots. These researches are carried out on a Malvaceae, Cotton, which is of agronomical interest.

Morphological modifications appear especially on roots, with, for instance, formation of tuberized zone after a drought period (3).

Biochemical modifications affect the amount of amino acids (proline)(1)(2), soluble carbohydrates (sucrose - fructose)(4), organic acids (malic). This results in a global "adaptative modification", even if each substance has an specific effect (osmotic regulation, membrane permeability, possible changes into CAM metabolism)(6). We observe the importance of the rate of accumulation of substances which are characteristic of a stress. They are accumulated fastly in sensitivie species, and slowly in more resistant ones. The rate of response to the stress is a good index of resistance.

Drougth resistance is depending of environmental factors: especially with photo-period, we have resistant plants for short day. This result is under dependance of phytochrome (exp. With red light and far red light) (5). Rate of accumulated substances during drought follows the same cinetic; fast in sensitive plants; slow in resistant ones. We observe also an intensive accumulation of abscissic acid with long day. The action of phytochrome and the amount of abscissis acid permit hypothesis of permeability different with photoperiod.

Drought resistance increases also when a fresh temperature is given to roots. Experiments permit hypothesis of hormonal and membrane permeability modifications which can explain variations of water amount for the foliar system, and, of course, difference of resistance.

If our work is directly in relation with drought resistance, it includes problems of environmental stress resistance. So, cold and salinity give same effects. We have shown importance of correlations between leaves and roots with many metabolic modifications. Our researchs about photoperiod, show phytochrome role and lead to cellular study with membran permeability.

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F.-ADAPTATION TO DROUGHT

(N. VARTANIAN)

According to experiments in Ecology on resistance to drought, the root system plays a decisive role in how plants adapt to water deficit. While doing ecophysiological research on the influence of environmental hydric factors on the influence of environmental hydric factors on the root system of an annual mesophytic specie, Sinapis alba, we brought to light a latent rhizogenetic adaptative potential to drought, which could also be found in many other Dicotyledonous annual species originating from various ecological habitats, the adaptative character appearing to be a potential of the family rather than of species.

When plants are grown under conditions of soil or atmospheric drought, increasing progressively water deficit, rhizogenesis of lateral roots is stimulated while growth of the main root is inhibited. However these new roots which have no absorbent hairs, do not grow in lenght as long as drought lasts and develop a tuberised aspect. The histological study made in Sinapis alba shows a structure of primary root where all the histological zones exist, without any change in the number of cell layers. However different characteristics appear: inhibition of longitudinal elongation, radial growth of cortical cells, accelerated cell differentiation. During ageing under arid conditions, cortical cells become hypertrophied and accumulate considerable amount of starch. This new synthesis appear transitory and localized because a gradual hydrolysis, resulting in a high glucose level, occurs in the entire root system during drought, and indicates hardening that gives a survival potential at the root level.

The evolutive potentiality of these roots is revealed when growth of drought plants is resumed after the soil has been watered: short tuberized roots are then able to grow in length, branch out and acquire functional absorbing role. Their adaptative nature can be proved by comparative analysis of the increase in weight of plants submitted to drought and watered again, to control plants regularly watered.

It seems that drought would act as a signal that can induce, in some species with large morphogenetic potential, a sudden burst of specialized roots that might correspond to high increase in growth regulators. Overall aspects of the problem are now attempted with different methods of investigation: cytology, experimental morphogenesis, biochemistry, ecophysiology, genetic.

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G. ADAPTIVE MOLECULAR AND METABOLIC MECHANISMS

(O. QUEIROZ)

A model currently developed in the Phytotron for the metabolic mechanisms of adaptation introduces for the first time the hypothesis of a regulatory role of enzyme capacity as a parameter distinct of enzyme activity. On the basis that slow enzymic mechanisms are required for adaptation to environmental constraints, the model combines 2 different types of processes:

A. Endogenous circadian rhythms, which enable the plants to measure the progress of the day and of the season through coupling with photoperiodism,

B. readjustments of metabolic balances, through accumulation or depletion of specific chemical species according to the temporal program settled by mechanisms A.

Application of the model to the case of adaptation to drought by CAM plants afforded for the first time evidence that change in isofunctional forms of enzymes could be on early step of physiological control by photoperiodism. Type B mechanisms are also under current study in the cases of adaptation to salinity and to low, non necrotic pollution by SO_2.

I. The role of photoperiodism in the adaptation to drought: CAM plants

1. Rhythmical characteristics of CAM are under current systematic investigation in the Phytotron. A research program supported by the CNRS ("Action thematique programmee internationale",1979) is in progress involving the participation of laboratories at Darmstadt and Bayreuth (Germany) and Cadarache, CEA (France). The work on the rhythmical components of CAM develops along several lines:

a- causality of the endogenous circadian rhythm of PEP carboxylase capacity (established by earlier work in this laboratory): recent immunological studies, carried in collaboration with P. Gadal's laboratory at Nancy, strongly suggest that the daily variation in capacity could result from a rhythm of the relative amount of the active form of the enzyme (rather than a rhythm of net enzyme synthesis); rhythmical changes in enzyme characteristics (Km, affinity for effectors, response to pH) are under investigation. Photoperiod was shown to entrain the enzyme rhythm by the action of dusk and dawn signals.

b- determinism of the rhythm of actual enzyme activity in vivo: a model combining the effects of the rhythm of capacity and of feedback control by malate is investigated as a function of time of the day and level of CAM.

c- endogenous rhythm of malate decarboxylation in light: the control by a phytochrome transduced infbrmation has been shows; the site of thiscontrol is not yet established.

2. A seasonal adaptive process: through CAM enhancement by short days appears to involve:

-- an endogenous rhythm of sensitivity to light, established by dark interruption experiments,

-- the effect of conveniently timed dusk signals on the pattern of isofunctional forms of PEP carboxylase and on the level of enzyme capacity;

-- the effect of the dawn signal coupling malate decarboxylation with the onset of day.

3. The role of polyamines as a pH-stat mechanism to counter the acidifying effect of high malate contents in the cytoplasm is currently studied.

4. Metabolic coordination during changes in CAM level is under active research in regard to:

-- regulation of glycolytic rhythmicity
-- changes in phenolics
-- differential amino acid synthesis
-- role of cyanide insensitive respiration
anaplerotic role of CAM towards the TCA cycle
-- origin of carbon chains for B-carboxylation depending on CAM level and age of the leaves (isotopic discrimination studies).

II. Adaptation to salinity

Portulacea oleracea (C4 glycophyte), Cakile maritima(C3 halophyte) are utilised, together with the CAM plant K. Blossfeldiana in order to study the effect of salinity on a plant in which CAM operation has been induced by another environmental parameter (photoperiod). Results show, in particular:

-- day/night rhythms of PEP carboxylase capacity and Na^+ content in the leaves (except for K. Blossfeldiana, the leaves of which exclude Nat)

-- an increase, in all cases, of the level of PEP carboxylase or aspartate aminotransferase capacities depending on the external NaC1 concentration and on the species, together with complex changes in the organic acid/amino acid balance and in Kt content.

III. Non necrotic, continuous pollution by SO2

Work with Phaseolus vulgaris cultivated in specially designed growth chambers have shown, since 1977, that the primary response to low (0.1 ppm) SO2 pollution is a rapid increase in the capacity of the key enzymes of several metabolic pathways (RAP and PEP carboxylases, malate -, glucose-6-P, glutamate - , and isocitrate dehydrogenases, malic enzyme, phosphofructokinase, aspartate aminotransferase and peroxidases). This general, but temporary (2 weeks) increase in metabolic potentialities depends on the age of the leaf and appears to result in a higher resistance to further pollution. Recent results on the variations of metabolic pools are consistent with the enzymic readjustements.

Current research investigates the "physiological cost" of this adaptive response and the possibility of defining a biochemical test for an early detection of low pollution levels (work supported by the Ministere de l'Environnement et du Cadre de Vie, France, and the Commission of the European Communities).

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H.- THE REGULATION OF CATABOLISM IN ADENYLIC COMPOUNDS BY LIGHT

(J. Nguyen)

Adenine metabolism was studied in leaves in relation to the lighting conditions under which they were grown. In Pharbitis nil (COnvolvulaceous) *the* effect of lighting was able to be clearly shown for anabolism as well as for the catabolism of adenylic compounds over a period of 24 hours, the incorporation of adenine-8-^{14}C in the fraction of total nucleic acids is higher in leaves grown in light than those in darkness ; on the other hand, the radioactivity of adenylic catabolites is remarkably greater in leaves in darkness than leaves that are grown under lighting. (1)

It is this area of the regulation of catabolism of adenylic compounds by light which was studied in detail.

An increase in catabolism of adenylic compounds in darkness is noted in leaves of many species In plants, catabolism *is irreversibly* binding by molybdoflavoprotein which is a xanthine dehydrogenase, dependent on NAD+ and, to a lesser degree, ai NADP4'. The activity of this enzyme was not able to be detected in the principle cellular organites such as chloroplasts and peroxysomes. This enzyme can be considered as being soluble. (21

An analysis of the influence of lighting on the level of in vivo activity of xanthine dehydrogenase showed that activity only increases in darkness after a latent period of 8 hours and reaches a plateau at the end of 30 hours ; on the other hand, inhibiting this activity by light is immediate and relatively rapid because after 8 hours of lighting t activity is reduced to a level close to a minimum value (3)

It has been shown that increasing catabolism of adenylic compounds in darkness is related to an increase of in vivo activity of xanthine dehydrogenase. The activity of the preceding reactions (de saminative phase) and that of the following reaction(uricassis) are not increased in darkness . (4)

A study of the influence of light on the activity of xanthine dehydrogenase made it possible to show that action depends on photosynthetic activity. (5) Recent results suggest that light has an effect on the in vivo activity of *xanthine* dehydrogenase due to the fact that it modifies the cellular environment and, especially, the osmotic state of foliar cells resulting from the synthesis of photosynthetates. This leads us to consider study of the role of osmotic constraints in the regulation of catabolism of adenylic compounds,

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I - PHOTOMORPHOGENESIS AND PHYTOCHROME

R. JACQUES

It should be noted that most of our present knowledge of the phytochrome has been obtained from observations done on etiolated plants and many studies on the influence of light on green plants must be undertaken to help in understanding the kind effect of phytochrome. Research is centered on an analysis of the action spectrum of light (via phytochrome) on morph. Ogenesis, and for this. two experimental models were chosen the growth of stem internodes and floral induction .

1 - A rapid and easily measurable physiological response (a few hours), the growth of an internode on the. main stem of Chenopodium polyspermum , made it possible to *easily* show the role of the different irradiated organs, leaves and stem, on the growth by cellular elongation An important inhibiting influence on the stem growth is due to the presence of active phytochrome (P730) in leaves at the begi nning of the night, resulting in the spectacular effect a short far red irradiation on the sti-

munition of growth, It is primarily the two pairs of leaves, at the tip and at the base of the internode, which regulate its growth. An explanation for the correlation between leaves and stem is presently being sought by testing an hypothesis to show that phytochrome is able to modify the transport of assimilates from leaves .

2 - Floral induction of some long day plants by light some in rosette at the vegetative state (Blitum), others caulescent (Anagallis arvensis), can be described according to a single diagram. If the main light period (9h) is completed by 15 hours of light of various wavelengths, far red (X),700nm) is the most effective. red light having no effect . The most effective moment for light stimulation of flowering is limited to a few hours after *the* middle of the night, In these conditions , red light is very stimulating while a 15 hours irradiation has no effect. Thus a high P730/ total phytochrome (PT) ratio, has an inhibiting influence and a stimulating one successively on floral induction. In fact, the matter is complex because it is possible to modify the influence of a precise P730/PT ratio in function of light intensity during the day. In addition, as concerns the growth of plant leaves in rosette (Blitum), short far red irradiation at the beginning of the night is stimulating, contrary to that fourti in caulescent plants.

A relation, therefore, exists betwen the value of light intensity during the day and the role of the phytochrome during the night on the reaction of morphogenesis - the same photostationary state between two forms of phyto chrome can have different influences resulting from. the preceding light intensity during the main light period.

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J - MINERAL NUTRITION

(D. Scheidecker)

A research group in mineral nutrition is attempting to study, within different contexts, relations between root absorption of ions, transport over a long distance and accumulation. The Phytotron offers means for work on the one hand with the whole plant in good conditions and, on the other hand/to have the opportunity of testing environmental factors. Therefore, either the constraints imposed by environmental factors are directly recognizable, or other constraints can be modulated by their intermediary, in order to better apprehend their effects.

The first subject encompasses two lines of research :

-studies having a fundamental or practical nature on. the effect of light and temperature : the influences of lighting on the absorption and migration of potassium and calcium (Tomato, Feathered Ivy) ; influence of temperature and especially low temperatures on mineral feeding of Tobacco and Maize.

-research on the daily periodicity of the sap flow and the ascending transport of cations (Tomato, the head cut off above the first two leaves).

In the framework of the second subject, a study of regulations of an excessive mineral medium is taken up : media rich in calcium (Yellow Lupin, White Lupin, Horse-bean) , in calcium and phosphorous (Tobacco), in chlorine and in sodium (Citrus, Cotton, Datura, Bean, Hedysarum, Rose Laurel, Alfalfa).

These regulations fairly often result in a high accumulation of elements in certain organs or privileged tissues: calcium in the stem of Yellow Lupin, calcium and phosphorous in the root of Tobacco, sodium in the root and stem of the bean. Each time, we have attempted to specify the anatomical or cytological compartments concerned, the mechanisms called into play and the importance of their physiological and ecological role.

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K- ECOPHYSIOLOGICAL REGULATION OF SECONDARY METABOLITES

(L. COSSON)

"Secondary metabolites" make up a wide very diversified group, attesting to a large amount of plant biosyntheses We intend to study them based on two main lines of inquiry

- regulating their amount in terms of external factors and under aggressive conditions.

- using as a detector various physiological processes (differentiation, organoge, nesis development).

1 Tropanic alkaloids in Datura and in Duboisia myoporoides

The study of Datura under phytotronic cultivations has shown the important effect of lighting conditions on their tropanic alkaloid content (hyoscyamine and scopolamine),

A double gradient (scopolamine /hyoscyarnine range, total amount of scopolamine + hyoscyamine) was discovered in Duboisia myoporoides R. Br. Australian these values vary during the plant's ontogenesis and appear to depend on root-foliar correlations as a whole. Important modifications were made in the nitrogenous metabolism of Datura innoxia Mill. grown in a salty environment (sodium chloride), especially on the alkaloid level which shows an increase in amount for certain salt doses, without any great decrease in plant growth.

The in vitro cultivation technique allows for a study of relations between organogenesis and biosynthesis and for obtaining alkaloids by non-organogenetic tissue stocks .

2 . Polyphenols in Cannabis sativa

After having found two chemical types of Cannabis sativa originating in South Africa, the use of phytotroni c conditions revealed their stability throughout successive generations, on the one hand and the important differential effect of tempereAur, on the other a warm climate favors accumulating tetrahydrocannabinol (THC-C3), while a cool climate increases the amount of THC-C5..

This research is being continued by setting up a Cannabis sativa stock. with the aim of obtaining a biosynthesis of new active molecules •

3 . The Ecophysiology of Jasmine

This study has shown the important effect of climatic factors on the quantity and quality of essences from the flowers of Jasminum grandifloruml

4 . The Metabolism of Guanidines under in vitro cultivation

This research intends to show that the tumoral features of the crown-gall can be separated from its capacity for octopine biosynthesis. Maintaining in vitro stocks of crown-gall, in effect, results in stoping this biosynthetic pathway while all other features of the tumorous phase are retained.

The strong reaction of most of these "secondary metabolites" show that they are excellent detectors of metabolic modifications caused by environmental factors and reference points for certain physiological processes in the course of development.

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XI-THE BIOTRON : UNIQUE RESEARCH FACILITY

Editor's Note. Dr. T. T. Kozlowski, Director` of Wisconsin Biotron (USA) have sent us paper writeA by Ann Beckel-Kratz and printed in UIR/Research Newsletter (13: 6.10.1979). As part of this paper can interest our readers specially these who do not know for what research Phytotrons and Biotron are useful, we reproduce below some results and ideas oriented only and specially on plant research.

The University of Wisconsin Biotron has computer-controlled capacity to duplicate daily environmental conditions found in any region of the world - from the Tropics to the Arctic. As a sophisticated system of controlled environment facilities, the Biotron is a powerful tool for research. Devoted to work with both plants and animals, it is the only large facility of its kind in any American university.

Biotron experiments are often more informative than those conducted in the field, greenhouses, or standard growth chambers, says Biotron director Theodore T. Kozlowski, because control over the environment is more or less complete. In field experiments, there are problems in evaluating effects of individual environmental factors on plants and animals. Light, temperature, humidity,wind, and other factors are so interdependent that a change in one alters the others. In the Biotron, however, researchers are able to control environmental conditions, and change them in a systematic and reproducible way. Furthermore, a whole range of conditions is available simultaneously, allowing scientists to compare the response of plants and animals to different environments.

In addition to rooms and chambers in which specific "weather" conditions can be produced and controlled, the Biotron also has sound and vibration proof rooms, high and low pressure chambers, fish tanks, a wind tunnel, and fumigation chambers into which gases of various composition can be introduced.

The concept of a Biotron - a facility that would permit research on both plants and animals under controlled conditions - originated largely within the National Science Foundation (NSF). In 1959, NSF awarded the University of Wisconsin $1.500.000 for the purpose of building a Biotron. But construction did not begin until 1964, after additional funds were obtained from the Ford Foundation ($1.700.000), the National Institutes of Health (NIH) ($1.000.000), and the state of Wisconsin ($313.351). The first formal research project was initiated in 1967.

During the past 12 years, the Biotron has provided research facilities for several hundred investigators from the University of Wisconsin, and from other uni - ifersities ***and*** industries as well.

Bacteriologist Winston J. Brill is investigating ways in which nitrogen fixing bacteria - bacteria that assimilate nitrogen from the atmosphere - can be used to increase crop yiels and reduce the need for nitrogen fertilizer. Since industrially produced nitrogen fertilizer will become increasinglyZare and expensive in the future, biologically produced nitrogen offers an ecologically and economically attractive alternative.

Other scientists are using precisely controlled environments in the Biotron to breed for disease resistance in economically important plants. For example, butternut canker has recently ***been*** recognized as a serious forest disease in Wisconsin. The pathogen responsible for butternut cankerdreatens to eliminate butternut trees from Wisconsin, at least as a commercial species, Forest geneticist Raymond P. Guries and forest pathologist James E. Kuntz are attempting to breed for disease resistance in butternut trees.

In other agriculture and forestry related projects:

Agronomist Neils C. Nielson from Purdue University is studying the effect of light intensity on protein and oil content of different varieties of soybeans.

Agronomist Jerry D. Doll is investigating inhibitory effects of certain weed species on crop plants, such as corn, alfalfa and soybeans, under conditions varying in temperature and relative humidity. Results of his study will provide valuable information to farmers growing these crops in fields with weeds capable of exerting inhibitory effects.

Entomologists Wendell E. Burkholder and Theodore J. Shapas are attempting to determine the effects of temperature on behavior of warehouse beetles, and on the sensitivity of male beetles to their sex pheromone, a chemical atrractant emitted by females. Information from these types of studies can be used in pest management programs.

Agricultural engineer Benjamin F. Detroy of the United States Department of Agriculture is studying effects of increasing levels of carbon dioxide and relative humidity on containerized honey bees in order to establish tolerance levels. Knowledge of tolerance levels for carbon dioxide and relative humidity can be used to provide improved facilities for overwinter storage of bee colonies, for shipping containers, and for transportation of bees.

Plant pathologists Christen D. Wpper and Deane C. Array and meteorologist William R. Barchet are using the Biotron's wind tunnel to analyze the extent to which epiphytic bacteria - bacteria that growl• on the surface of plants and derive their moisture and nutrients from air - might be a source of atmospheric ice nuclei. Atmospheric ice nuclei are important in the formation of precipitation, but the exact nature and source of ice nuclei are unknown. Circumstantial evidence suggests that terrestrial plants may be a major source. The interdisciplinary research team is measuring the effects of wind on erosion of epiphytic bacteria from plant surfaces.

Some of the most pervasive and potentially harmful environmental pollutants and their effects on plants and animals are being studied in the Biotron. Fumigation chambers have proved particularly useful for examining the effects of air pollutants, such as sulfur dioxide and ozone, on plants. Some of the studies now underway include research by:

Forest biologist and Biotron director Theodore T. Kozlowski is investigating how environmental factors, such as light intensity, daylength, temperature, relative humidity, and wind influence effects of sulfur dioxide and ozone on woody plants before , during, and after exposure to the pollutants. He is also studying mechanisms of pollution resistance in plants.

Theodore W. Tibbitts of the horticulture department is attempting to answer questions about how environmental factors interact to influence pollution sensitivity in pea plants. Results of his research will provide information that can be used to predict the pollution sensitivity of plants in the field under different environmental conditions.

In the 12 years the Biotron has been operating, its usefulness to researchers has been continuously improved by the acquisition and construction of new facilities and equipment.

"New and creative uses of the Biotron are encouraged" says Biotron director Kozlowski."We try to keep the facilities flexible so that we can provide opportunities for new types of research ideas and projects".

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XII.-PROBLEMS IN THE USE OF PHYTOTRONIC INSTALLATIONS FOR RESEARCH AT THE RESEARCH INSTITUTE-ON RICE (Krasnodar, USSR)

by E. P. Aliochine, V. B. Romanov

Translation - N. S. Sorokina

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These last years have seen a rapid development of rice production in the USSR. This growth in rice production is due, in great part, to the work of research scien tists and accounts for the establishment in 1966 in Krasnodar of a Research Institute on ***Rice,*** a center which coordinates all research in the area of rice culture in the USSR.

One of the main tasks of the Institute is to obtain new varieties of rice with high yield, good resistance to disease and parasites, good tolerance to high doses of fertilizer, with seeds having good technological and culinary characteristics.

In selecting new varieties of rice, researchers must give increased thought to reducing the selection process and to doing a special study of these varieties in rigorously controlled environmental conditions, as well as other problems where a solution would require air conditioned installations.

At the Institute presently there are 11 air conditioned installations, of which 5 are growth chambers of the KB-1 (USSR) type, I is an air conditioned low temperature chamber of the KNT-I (USSR) type, and 5 growth chambers of the CEL (USA) type. The characteristics of all these installations are found in Table I. Lighting and tempe- rature regulation is programmed in the KB and CEL types of growth cabinets.

As can ***be*** seen in Table I, the number of control parameters in these installations rides not exceed 4. This situation allows for a fairly limited number of problems that could be solve4d by using these chambers.

During these last years Institute research scientists have been using the instal- lations mentioned to solve the following problems,: elaborating optimal techniques for rice culture, creating climate models for various rice growing areas in order to try out new varieties of rice, cultivating regenerated plants from tissues, testing varie- ties of rice resistant to low temperatures, and elaborating optimal conditions for hybridization.

Elaboration of technique for rice culture and hybridization was done in these chambers of the KB and CEL type. Insufficient lighting and an absence of air humidifiers compelled Institute research scientists to give up using the CEL type for formulating conditions for rice culture. Far research on hybridization, additional humidifiers were installed in KB chambers, which made it possible to maintain relative humidity in ***theme*** on the order of 80-95%. Thus, different industrial growth installations must be appropriate to the culture which will be cultivated in them.

It should be added that the Institute's material and technological plans have not yet been entirely carried out. A phytotron under construction, will include in the future about 40 air conditioned installations, where the most important role will be assigned to KB-1 and KB-2 type cabinets and some KNT-1 low temperature chambers. In addition to the Phytotron, two greenhouses will be built at the Institue (600 m2 usable surface area), two growing plant greenhouses without additional lighting and without air conditioning (200 m2 usable surface area) and 8 small greenhouses (24 meters of usable surface area).

These greenhouses are reserved for research work done in the autumun, winter and spring. The largest greenhouses will be fitted with concrete reservoirs in which will be placed stainless steel containers reserved for rice plants. Above each container a mercury vapor fluorescent lamp will be installed for additional lighting during cloudy days. The characteristics and climatic parameters of greenhouses and of the Institute phytotron have been described by A. G. Anikine (1).

Putting into operation the aforementioned installations will allow Institute research scientists to broaden their field of experiments and to consider research in the physiology, phytopathology, entomology, protection of rice plants, and in other fields.

It should be noted that even by putting into operation a biological - industrial complex made up of a phytotron and greenhouses, problems will cone up that research scientists will not be able to solve without the help of phytotronic engineers.

We know that using growth chambers and cabinets manufactured in various countries of the world will allow us to create and control only 4-5 climatic parameters. This excludes the possibility for modelization of the complex of parameters making up a phytoecosystem, including in it the climatic, gaseous, nutritive and lighting of plant cenoses.

As research intensifies, polyfactorial information about the interdependence of plants and their surrounding environment will be required. This calls for the creation of phytotronized installations where modelization and recording ambient factors can be controlled with 15-25 indexes.

All of these presently unsolved problems make anxious phytotronic research scientists in a number of countries.

Resolving these problems t* one of the main tasks to be undertaken by engineers working in various branches of industry. Solutions must be obtained rapidly by specialists in different countries pooling their efforts.

Bibliography

1. A. G. Anikine, E. E. Karpis, A. P,Primak. A guarantee of controlled environment pare-, meters in phytotrons. Phytotronic Newsletter n* 17, February 1978.

Table I. Characteristics of Air conditioned Installations

Type of instal-tion	Temperature C	Relative air Humidity	Lighting lx	Usable surface area m2	Power consumed KW
KB _	+ 10 - + 45	55 - 70	50 000	3.5	45
KHT _1	- 30 - + 10			8.0	6
CEL 38-15	+ 5 - + 45		35 000	1.4	9
CEK 511-38	+ 5 - + 45	-	40 000	3.4	2.3

XII:CLIMATE MODELIZATION IN PHYTOTRONIC INSTALLATIONS t

V. B. Romanov

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The importance of phytotrons in biological research need not be reiterated. Modelization of ambient conditions in phytotrons is also an important problem. Growth chambers, which are part of the phytotron, are generally programmed by climatic parameters equipment. Properly calculated and correctly realized operating programs greatly influence the value of the results from research done at the phytotron.

One of the stages in climate modelization in phytotronic installations consists of setting up climate models of the zones in which research scientists are interested.

Such models serve as a basis to construct operating programs for air conditioned phytotron cabinets, where meteorological conditions of an area or a well-determined zone will be reproduced.

This article is divided into two parts:

Part I. Calculations for and Creations of Climatic Models
Part II. Calculations for and Creations of Programs for Air Conditioned Chambers.

Part I.

Calculations for and Creations of Climatic Models

This part of the article is devoted to the work done for creating climatic models of rice culture zones in the USSR. In air conditioned chambers it is generally possible to regulate temperature and relative air humidity, lighting and photoperiodic durations. This is why we have calculated and set up climatic models for these parameters.

Models for different rice culture zones can be constructed on the basis of meteological averages, found in the USSR Climate Guidebook (2, 3, 41, where data is based on observations done over at least the last 20 years, which is a earantee of their worth In setting up programs for phytotrons biologists anal engineers above all are interested in the daily variations in meteorological factors and in the evolution of these variations during the entire growing period.

However, in the Guidebook mentioned above, only average monthly of air temperature are listed. As for the other factors (relative air humidity, intensity of radiations, global radiation), only momentary results of observations done during the day are - to be found. Therefore, this data does not give a complete picture of hourly variations of meteorological factors during a month nor does it make it possible to construct available climatic models based on these variations.

The nature of daily or annual meteorological variations is expressed with the aid of trigonometric functions. This is why it is possible to determine the daily variations of these factors, by making very precise observations for four periods (1, 7, 13, 19h) or five periods (6.30, 9.30, 12.30, 15.30, 18.30h). Moreover, by using trigonometric functions, variations over a week, a decade or a month can be calculated.

Certain authors (5, 6) have constructed climatic models for different zones by generally using values of monthly meteorological reviews, collected over 5-20 years.

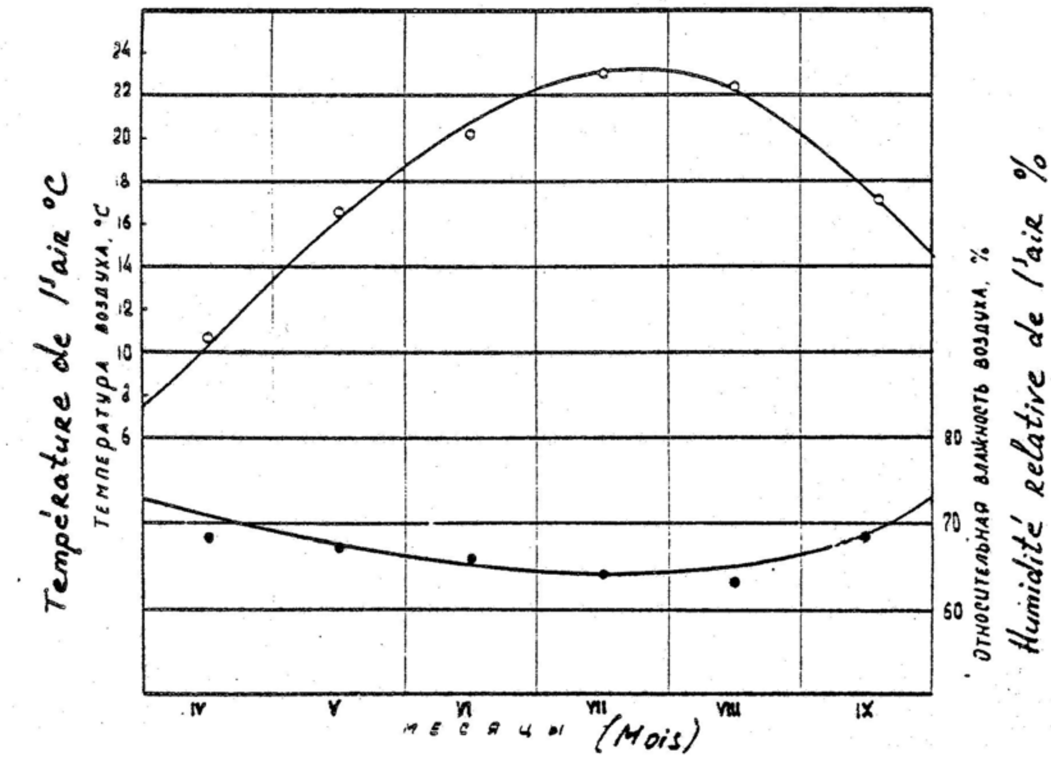

Figure 1. Annual variations of temperature (°) and relative air humidity (•) in the Krasnodar area.

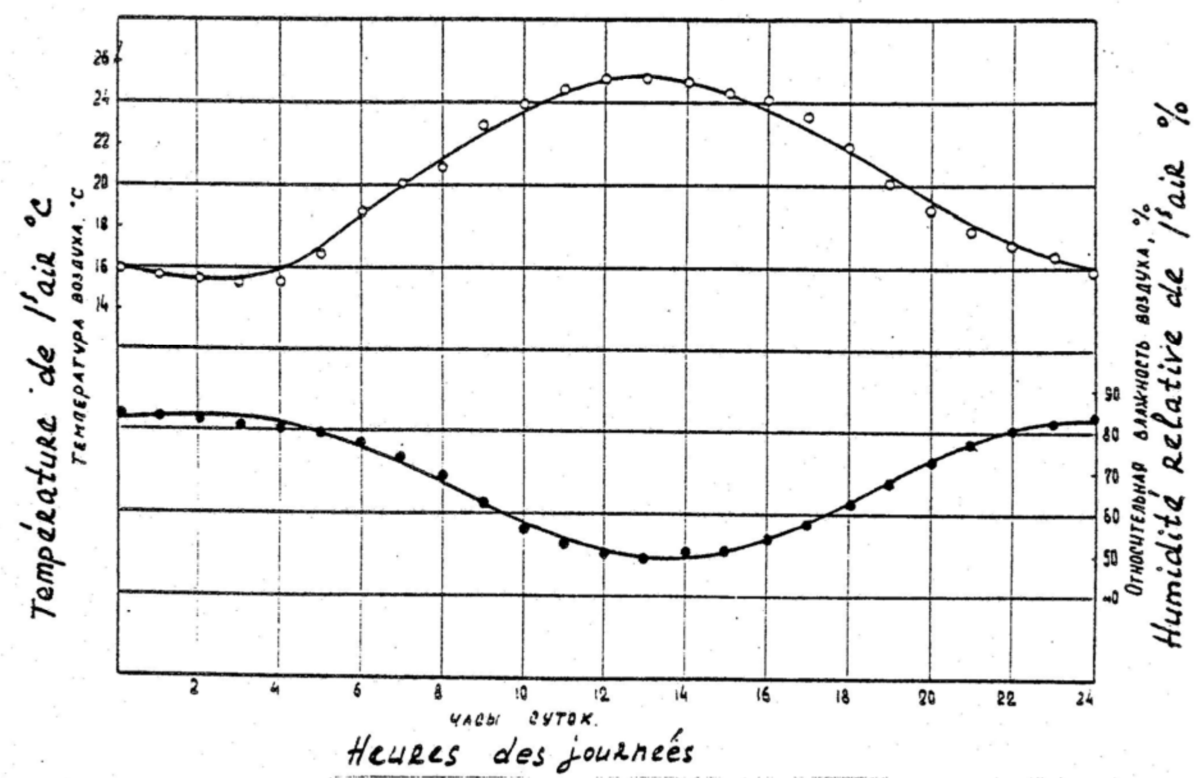

Figure 2. Variations of mean monthly temperature (°) and relative humidity (•) in the month of June in the Krasnodar area.

These authors have found that constructing climatic models should be done from data collected over at least 15 years. If the observation time is less, deviations increase for the values calculated with respect to average annual values.

In this article can be found the main aspects of climate model construction and the calculations which are related to it. Work is based on curves of meteorological variations, recorded by meteorologists at fixed and equal intervals - 1 hour, 1 day, 5 days, a number of months.

Meteorological observations Y_t done at regular intervals at points t = 0,1 .... (k-1) can be considered as a Fourier series:

$$Y_0 \text{ , } Y_1, \text{ .... } Y_{k-1} \qquad (1)$$

obtained at points t = 0,1....., (k-1) and their values can represent a concrete realization of Y_t observations. The Fourier series (1) can be presented as follows:

$$Y_{(t)} = a_o + \sum_{p-1}^{n} (ap \text{ Cos } w_p t + b_p \sin \omega_p t), \qquad (2)$$

where p - power of the polynome (p = 1,2 ....n),

n - integer, $\omega p = 2 \Pi p/k$ k - number of periods,

a_0, a_p, b_p - unknown coefficients that should be calculated.
To facilitate the research, we assume that the constant $\omega = 2\Pi/k$ represents the value of the time unity t = 0,1 ... (k-1) reduced to the angular unity (rd). The equations for calculating unknown coefficients are:

$$a_o = \frac{1}{k} \sum_{t=0}^{k-1} Y_t$$

$$a_p = \frac{2}{k} \sum_{t=0}^{k-1} Y_t \text{ Cos } \omega_p . t \text{ ;} \qquad (4)$$

$$b_p = \frac{2}{k} \sum_{t-0}^{k-1} Y_t . \text{Sin } \omega_p . t \text{ ;}$$

where a_0 is the arithmetical mean of the Y_t values observed. To calculate a_p and b_p coefficients, it is necessary to determine the Cos $\omega_p t$ and Sin$\omega_p t$ values for different periods of equal duration from t = 0 to t = k-1.

To make the equation simpler the value of the cosinus can be expressed by U_p and the value of the sinus by V_p, and then the equation reads:

$$\text{Cos } \omega_p . t = \text{Cos } \frac{2\Pi . p}{k} . t = U_p$$

$$\text{Sin } \omega_p . t = \text{Sin } \frac{2\Pi . p}{k} . t = V_p \qquad (4)$$

To facilitate subsequent calculations we give the values calculated for U_p and V_p in a Table. Since only hourly daily variations as well as monthly variations of meteorological factors are those which interest us in constructing climatic models, the number of k periods in this Table will be 12 and 24.

J.Bliss and J.Pletser (5, 6) note that to construct curves of variations of meteorological factors for coefficients a_p and b_p, the power of the polynome must be equal to

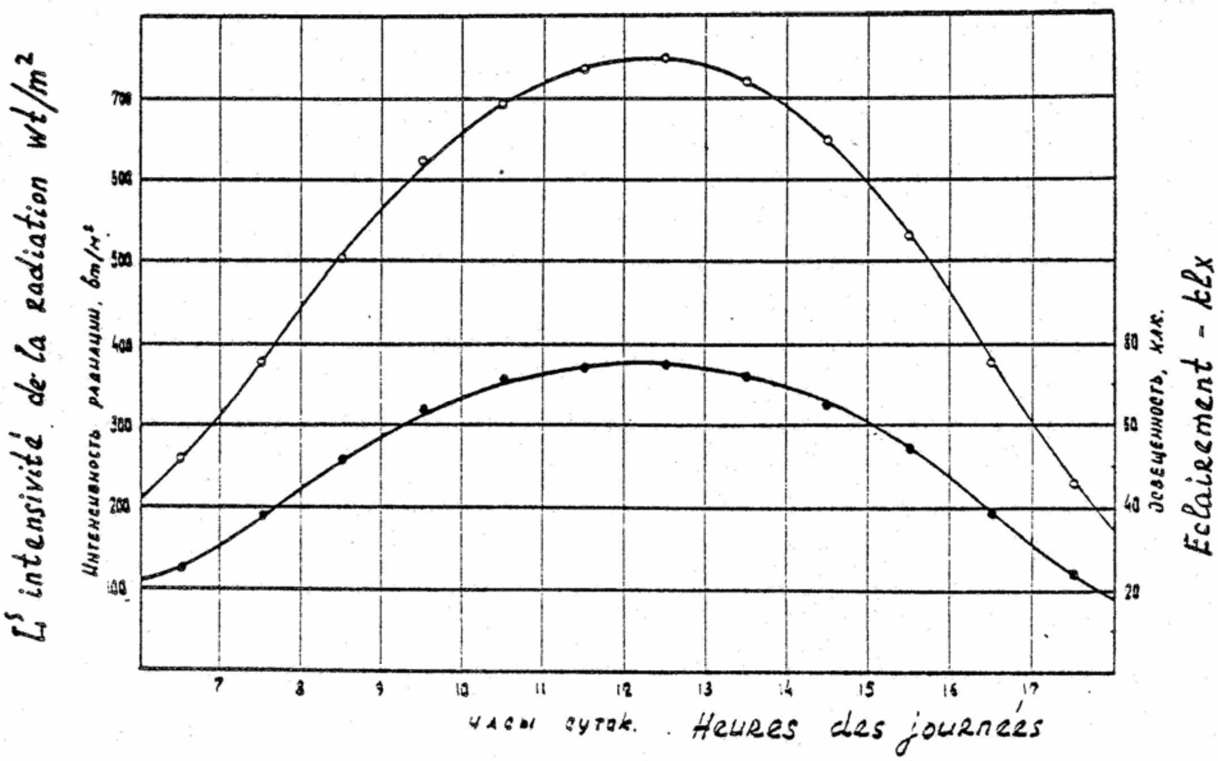

Figure 3. Variations of daily radiation intensity (°) and lighting (•) in the month of June in the Krasnodar area.

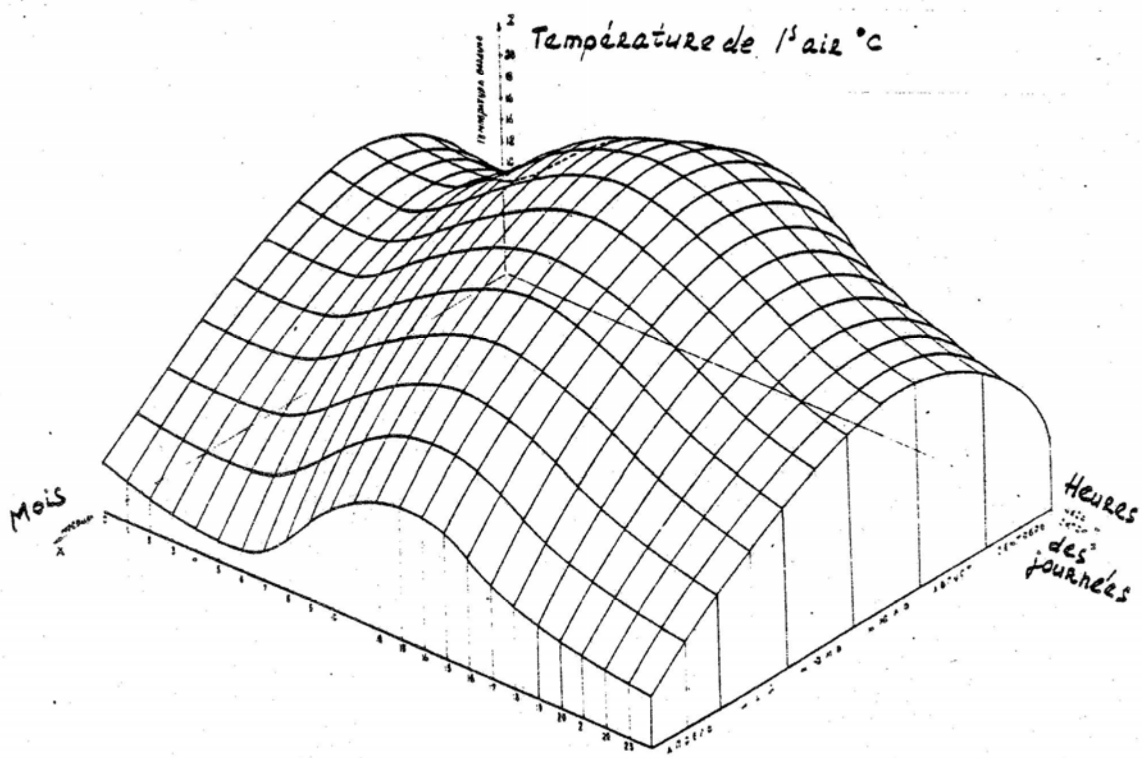

Figure 4. Relation between air temperature and hours of the day throughout the growing period in the Krasnodar area.

Table 1. (Part I) U_p and V_p values for k = 24 and k = 12 periods. Time lapse equal from t = 0 to t=k - 1.

t	K=24						K=12					
	U1	V1	U2	V2	U3	V3	U1	V1	U2	V2	U3	V3
0	1	0	1	0	1	0	1	0	1	0	1	0
I	0,966	0,256	0,866	0,5	0,5	0,866	0,866	0,5	0,5	0,866	0	I
2	0,866	0,5	0,5	0,866	-0,5	0,866	0,5	0,866	-0,5	0,866	-1	0
3	0,707	0,707	0	I	-I	0	0	I	-I	0	0	-1
4	0,5	0,866	-0,5	0,866	-0,5	-0,866	-0,5	0,866	-0,5	-0,866	1	0
5	0,259	0,966	-0,866	0,5	0,5	-0,866	-0,866	0,5	0,5	-0,866	0	1
6	0	1	-1	0	1	0	-1	0	1	0	-1	0
7	-0,259	0,966	-0,866	-0,5	0,5	0,866	-0,866	-0,5	0,5	0,866	0	-1
8	-0,5	0,866	-0,5	-0,866	-0,5	0,866	-0,5	-0,866	-0,5	0,866	1	0
9	-0,707	0,707	0	-1	-1	0	0	-1	-1	0	0	1
10	-0,866	0,5	0,5	-0,866	-0,5	-0,866	0,5	-0,866	-0,5	-0,866	-1	0
11	-0,966	0,259	0,866	-0,5	0,5	-0,866	0,866	-0,5	0,5	-0,866	0	-1
12	-1	0	1	0	1	0						
13	-0,966	-0,259	0,866	0,5	0,5	0,866						
14	-0,866	-0,5	0,5	0,866	-0,5	0,866						
15	-0,707	-0,707	0	1	-1	0						
16	-0,5	-0,866	-0,5	0,866	-0,5	-0,866						
17	-0,259	-0,966	-0,866	0,5	0,5	-0,866						
18	0	-1	-1	0	1	0						
19	0,259	-0,966	-0,866	-0,5	0,5	0,866						
20	0,5	-0,866	-0,5	-0,866	-0,5	0,866						
21	0,707	-0,707	0	-1	-1	0						
22	0,866	-0,5	0,5	-0,866	-0,5	-0,866						
23	0,966	-0,259	0,866	-0,5	0,5	-0,866						

2 or 3. By using the data in the Table, an equation can be set up to calculate these coefficients if k = 24, p = 1, p = 2 and p = 3, in which case in the Y_t equations, the values of meteorological factors are taken from Climatic Guides (2, 3, 4). For example, the equations for a_1 and b_1 can be given as:

$$a_1 = \frac{1}{12}\Big[(y_0 - y_{12}) + 0,966 (y_1 - y_{11} - y_{13} + y_{23}) + 0,866 (y_2 - y_{10} - y_{14} + y_{22}) +$$
$$0,707 (y_3 - y_9 - y_{15} + y_{21}) + 0,5 (y_4 - y_8 - y_{16} + y_{20}) + 0,259 (y_5 - y_7 - y_{17} + y_{19})\Big] ;$$
$$b_1 = \frac{1}{12}\Big[(y_6 - y_{18}) + 0,966 (y_5 + y_7 - y_{17} - y_{19}) + 0,866 (y_4 + y_8 - y_{16} - y_{20}) +$$
$$0,707 (y_3 + y_9 - y_{15} - y_{21}) + 0,5 (y_2 + y_{10} - y_{14} - y_{22}) \; 0,259 (y_1 + y_{11} - y_{13} - y_{23})\Big] .$$

By analogy, equations for k = 12 are composed. To calculate the a_p and b_p coefficients, we substitute them in the equation (2) and we find the Y_t value for each deviation of time from t = 0 to t = (k-1).

The equation for calculating annual variation of air temperature in rice culture zones of the Krasnodar area is represented by the following equation:

$$Y_t = 10,5 - 12,7 u_1 - 0,8 V_1 - 0,11 u_2 + 0,016 V_2 + 0,08 u_3 - 0,4 V_3$$

In this case, the power of the polynome is p = 3. Relative air humidity has been calculated by using the equation :

$$Y_t = 74,0 + 10,8 u_1 - 2,16 V_1 + 0,9 u_2 - 1,3 V_2$$

In this case, p = 2 is sufficient, since the difference between the values calculated and the observed values for humidity does not exceed the admissible value. In Figure 1 a diagram can be seen of annual variations of temperature t and relative air humidity φ for the Krasnodar area from the month of April to September. The solid lines show the calculated values of t and φ and the points of observed values.

Calculations of daily t and φ variations as well as those of radiation and lighting intensity were done generally with p = 3, because with p = 2, in certain cases, the difference between calculated values and observed values exceed admissible values. Thus, for example, daily variations of the mean monthly air temperature in the month of June in the Krasnodar area were calculated according to the equation :

$$Y_{june} = 20,2 - 4,5 U - 1,6 V + 0,22 U_2 - 0,289 V_2 + 0,14 U_3 - 0,057 V_3$$

Relative air humidity has been calculated according to the equation :

$$Y_{june} = 68,08 + 16,208 U_1 + 6,41 V_1 - 1,35 U_2 - 1,67 V_2$$

The curves of daily variations t and φ (Fig.2) show a fairly satisfactory convergence with observed values.

In the same way, daily variations of radiation and lighting intensity (Fig.3) were calculated. However, in this case, calculations for variations were done using k =12 and not k = 24, since the longest day in the Krasnodar area latitute has 15,5 hours. Values for radiation intensity in the morning and evening were not taken into consideration, given their low values.

As has been already noted, in order to modelize an area's climate in a phytotron, it is necessary to know the daily variations of meteorological factors during the entire growing period, given that as a result of the earth's revolution around its axis and around the sun, meteorological factors vary from one day to another. Climatologist programmers also need to have a graphic representation of the dependence of meteorological factors versus the time factor. In this case, the time factor must be carried over on two axis: the axis of hours in a day and the axis of months. This means that

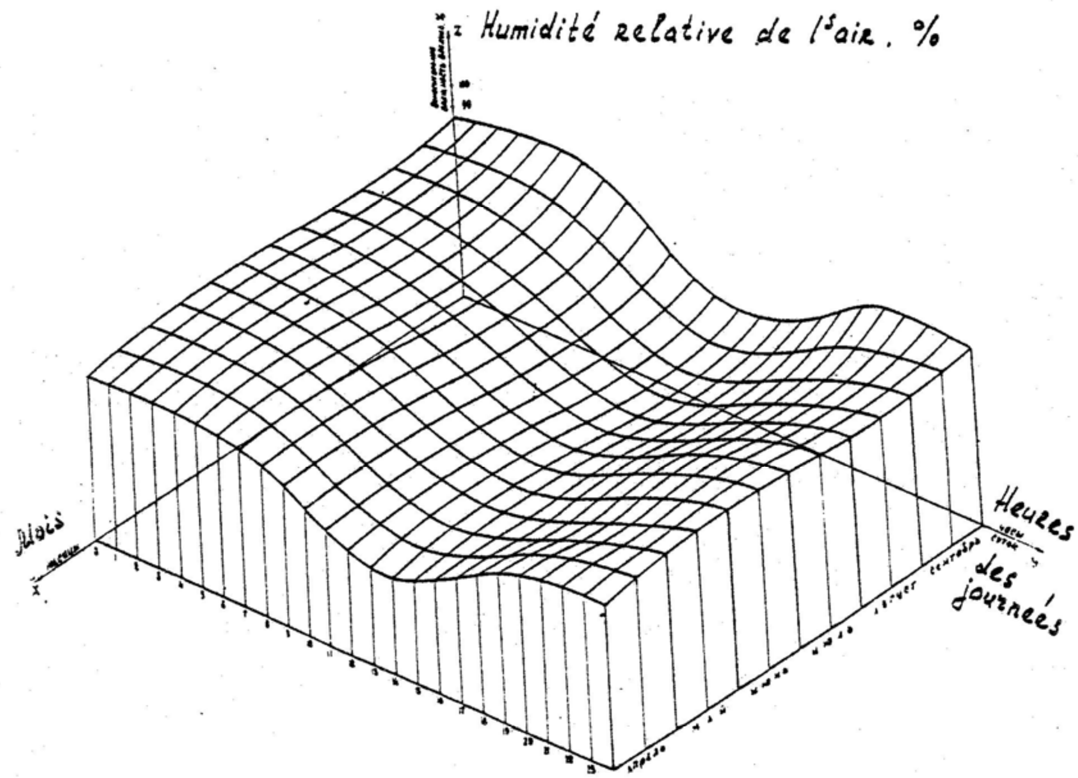

Figure 5. Relation between relative air humidity of the day in april in the Krasnodar area.

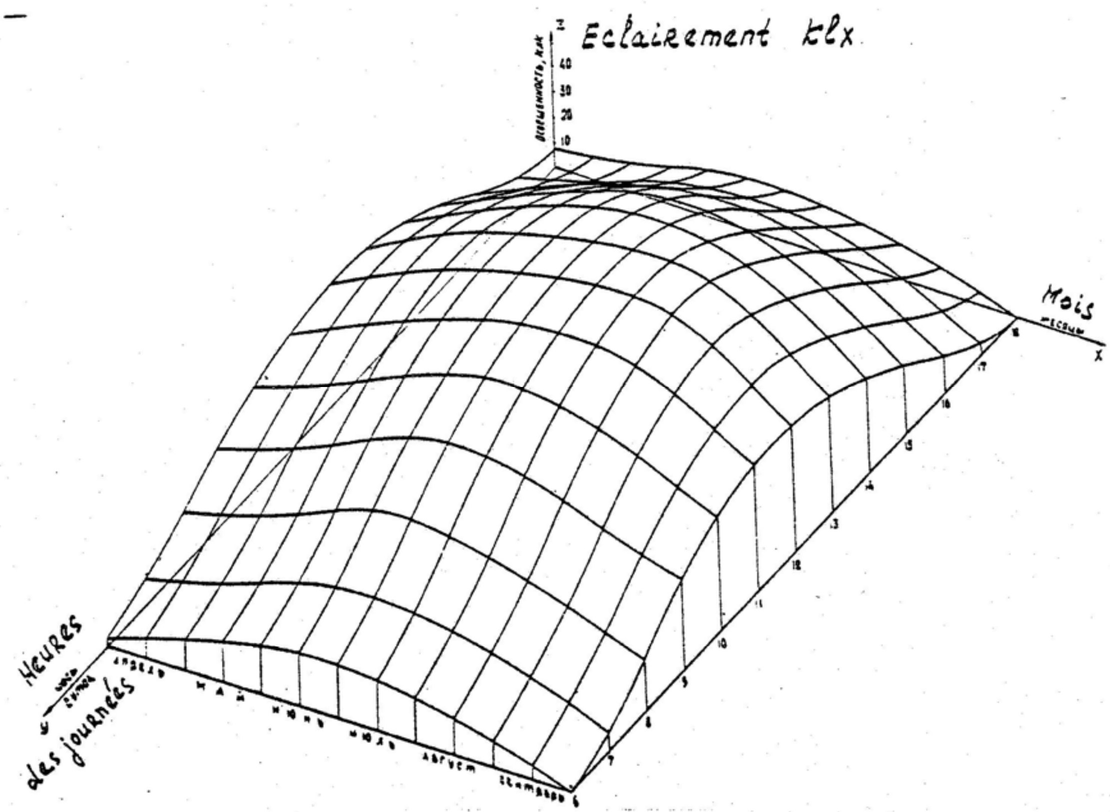

Figure 6. Relation between lighting and hours of the day during the growing period in the Krasnodar area.

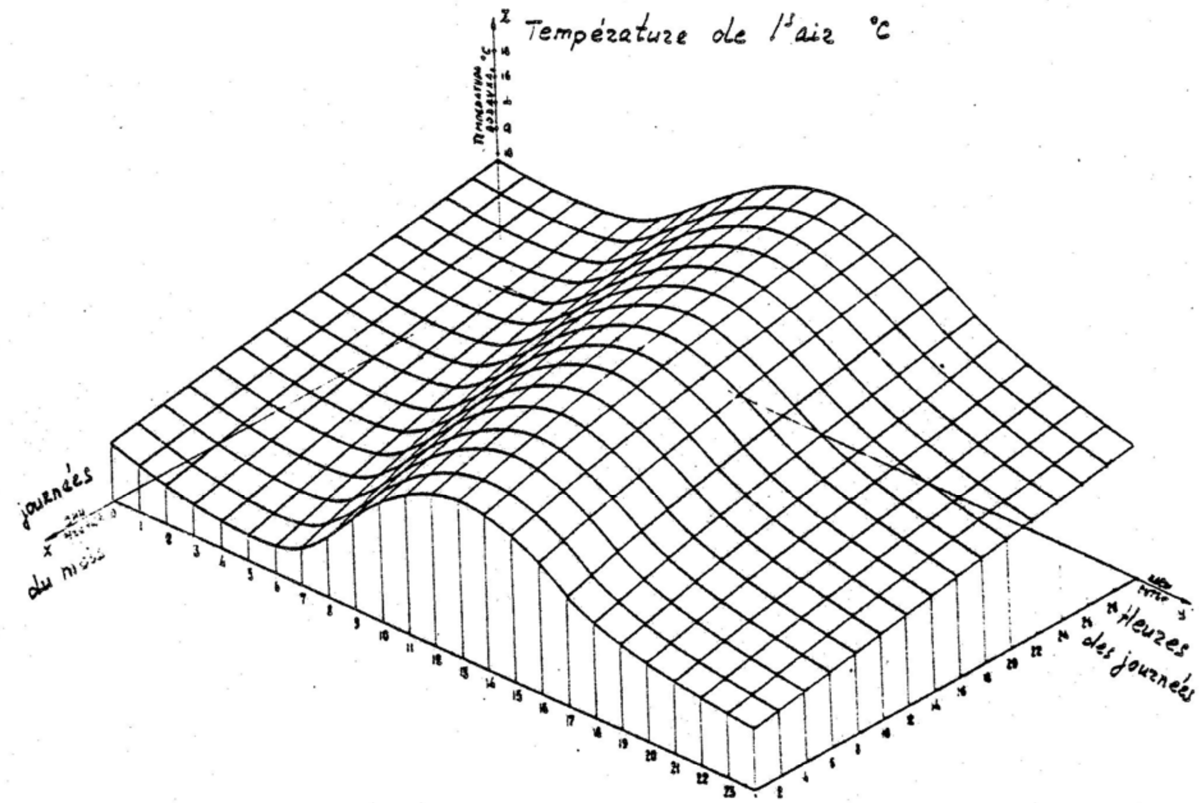

Figure 7. Relation between air temperature and hours of the day in april in the Krasnodar area.

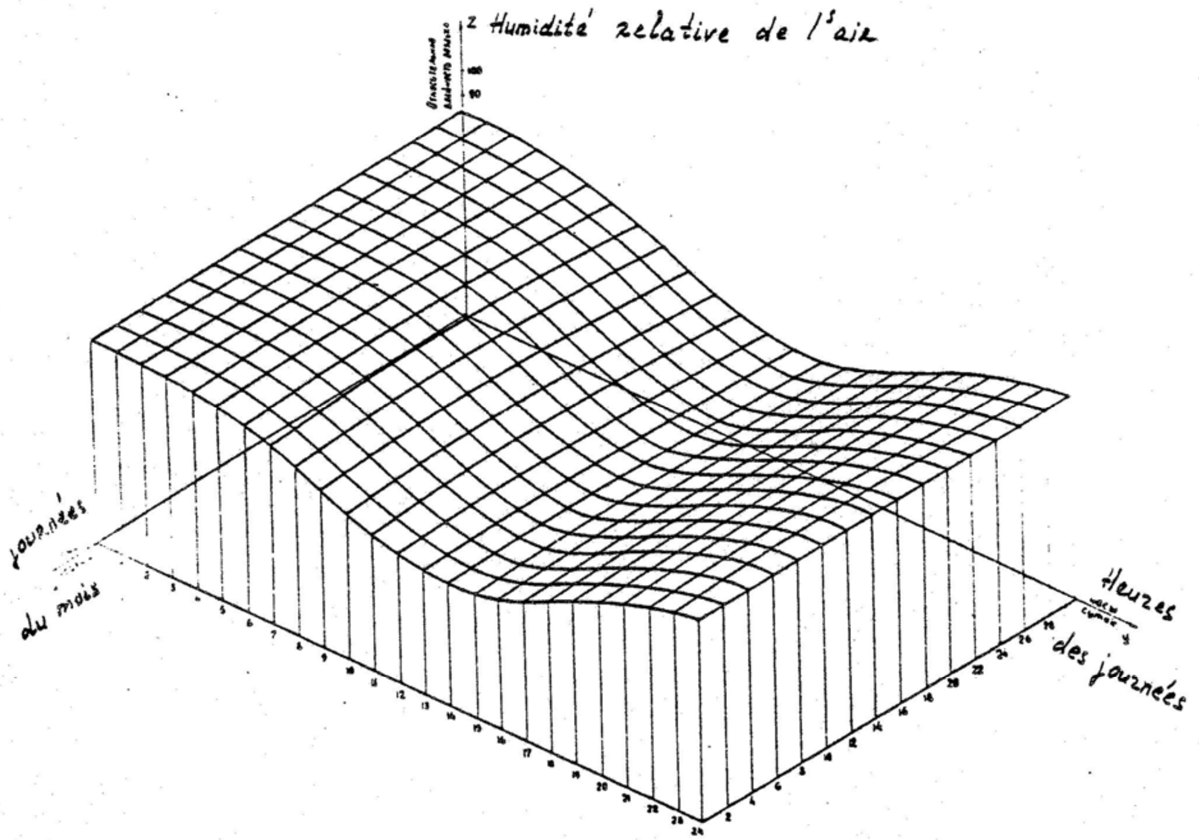

Figure 8. Relation between relative air humidity and hours of the day during the growing period in the Krasnodar area.

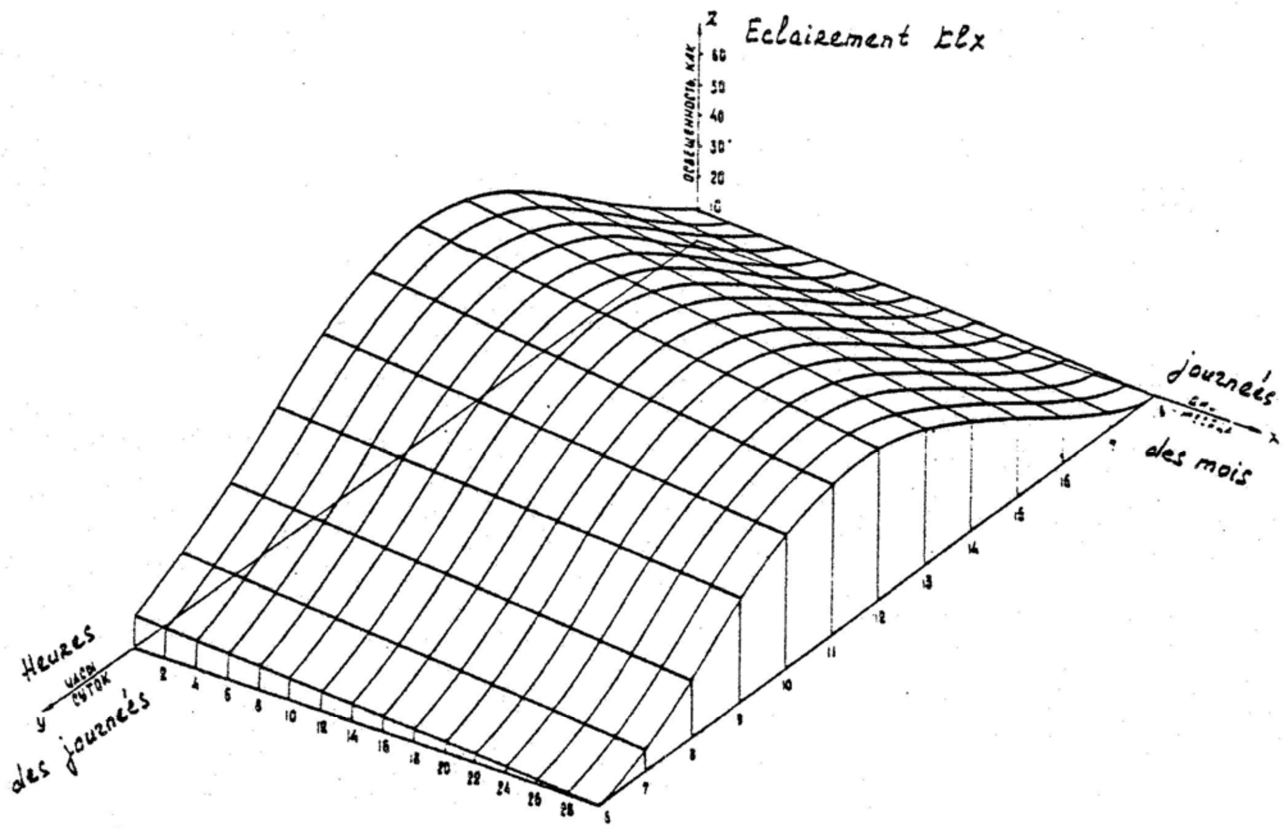

Figure 9. Relation between lighting and hours of the day in the month of september in the Krasnodar area.

the diagram of the dependence of meteorological factors versus the time factor must be represented in a tridimensional space.

In Fig.4 can be seen such a diagram of the relationship between air temperature as a function of time, where the air temperature is carried over on the Z axis, the months on the X axis, and the hours of the day of the Y axis. These diagrams in tridimensional space were constructed in the following manner. The planes parallel the UZ plane represent the values calculated for meteorological factors at each hour of the day for every month (April to September) and, as it has been explain for Figure 2, a series of curves are obtained. That show daily variations. Then, the curves are traced in the planes parallel to the XZ plane by using the hour points going in the same direction which show daily variations every month.

A second series of curves are obtained finally that together with the daily variation curves form a surface that characterizes changes in the air temperature factor (fig,4) throughout the entire growing period.

To illustrate this, we have produced diagrams of relative air humidity and lighting variations during an entire growth period in the Krasnodar area (figs.5 and 6). These diagrams give a general idea of the evolution of meteorological factors. However, it is quite difficult for climatologist programmers to use them, because of the small scale for months. As a matter of fact, it is nearly impossible to read every daily meteorological value.

To make these spatial diagrams easier for setting up daily programs, a large scale should be used for different months (fig.7). From such a diagram, it is possible • to set up daily air temperature variations for any day of the month. In the same way diagrams can be set up in a tridimensional space for relative air humidity and lighting for various months (figs.8 and 9).

Monthly diagrams shown on a large scale make it possible to work out daily pro grams for air conditioned chambers and to avoid drawing up a rather large number of Tables showing variations of meteorological factors.

Conclusions part I

By using trigonometric functions, calculations have been made of variations of the main meteorological factors which can be reproduced and regulated in a phytotron, Based on these variations, diagrams of variations of these factors versus time have been set up during the entire growing period.

These diagrams represent an approximate mathematical model of rice growing areas which can be used to set up climatic programs in phytotrons.

Part II
Calculations for and creations of Programs for Air conditioned Chambers

In biological research it is often necessary to reproduce climatic conditions of a region of the globe. Air conditioned chambers in phytotrons are used with this aim in mind. However, it is difficult to program climatic models in a chozen zone without having a good understanding of how air conditioned chambers-operate.

In Part I we have described a method for calculating and setting up climatic models for the Krasnodar area in the USSR (I). With the aid of these models climatic programs can be achieved in air conditioned chambers of phytotrons. These programs must be calculated and set up according to parameters that can be automatically regulated in growth chambers. As it was already noted, these parameters are the following:

I. Temperature and relative air humidity
2. intensity of radiation
3. duration of photoperiod

This is why all these climatic programs must be set up in terms of these parameters.

Air Temperature

Setting up climatic programs for meteorological conditions in the Krasnodar area is being planned. A graphic model of daily air variations in the month of June is shown in Figure I. Numerical values for models of daily temperature variations for Apri to September are given in Table 1. From this data air temperatures of the day and night must be determined. Above all, the limits for day and night temperatures must first be established.

B. Bretschneider-Herrmann (4) believes that it is the photoperiod that determines these temperature limits. This appears to be a reasonable assumption. If the curves of daily variations of radiation intensity are compared with those of variations in air temperature (Figure 1), it is not difficult to notice that the inflexion points for the passage of night temperatures and those of the day on the curve correspond to the beginning and the end of the photoperiod. In table.1.1innits between day temperature and those of the night are presented by solid lines.

After having set up these limits, daily averages (5) and those for the night (t_n) are calculated as well as the difference between them ' (t_i-t_n). The values calculated for the air temperatures will be used as a basis ' for setting up a temperature program in the growth chamber.

Calculating programs for extreme temperatures within the given limits to test new varieties is done in the same manner.

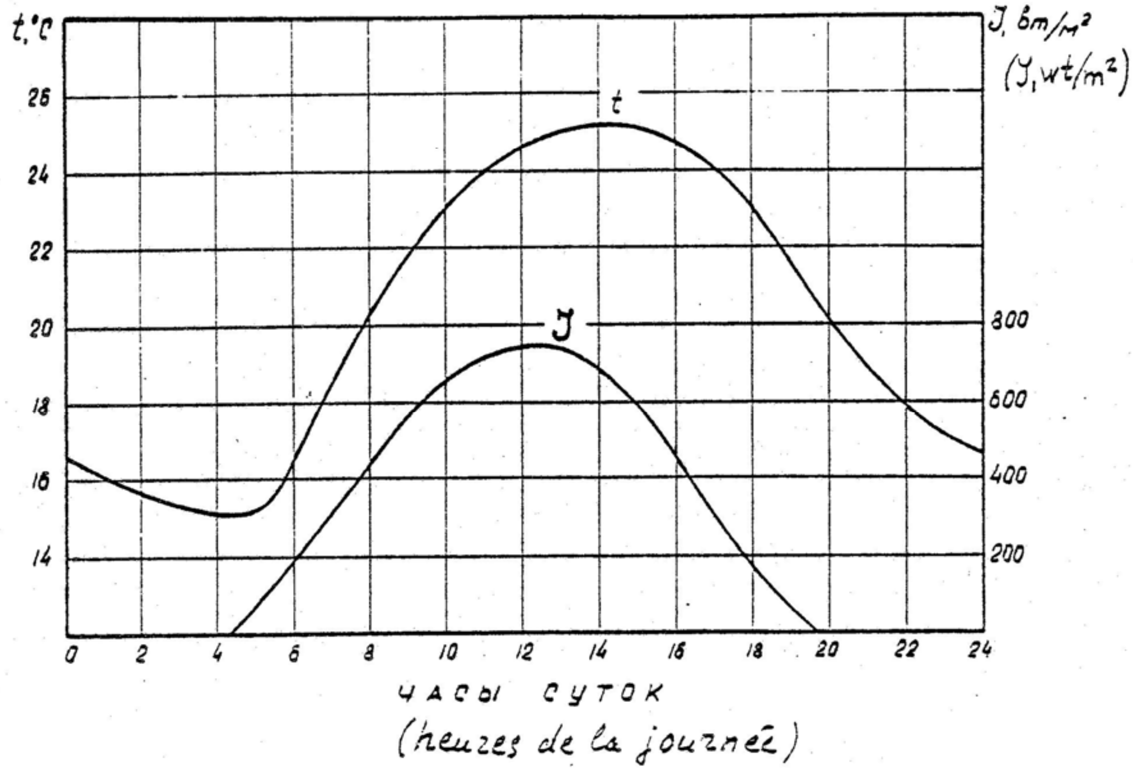

Figure 1. Models of daily air temperature variations (t) and intensity of solar radiation variations (I) in the middle of June in the Krasnodar area.

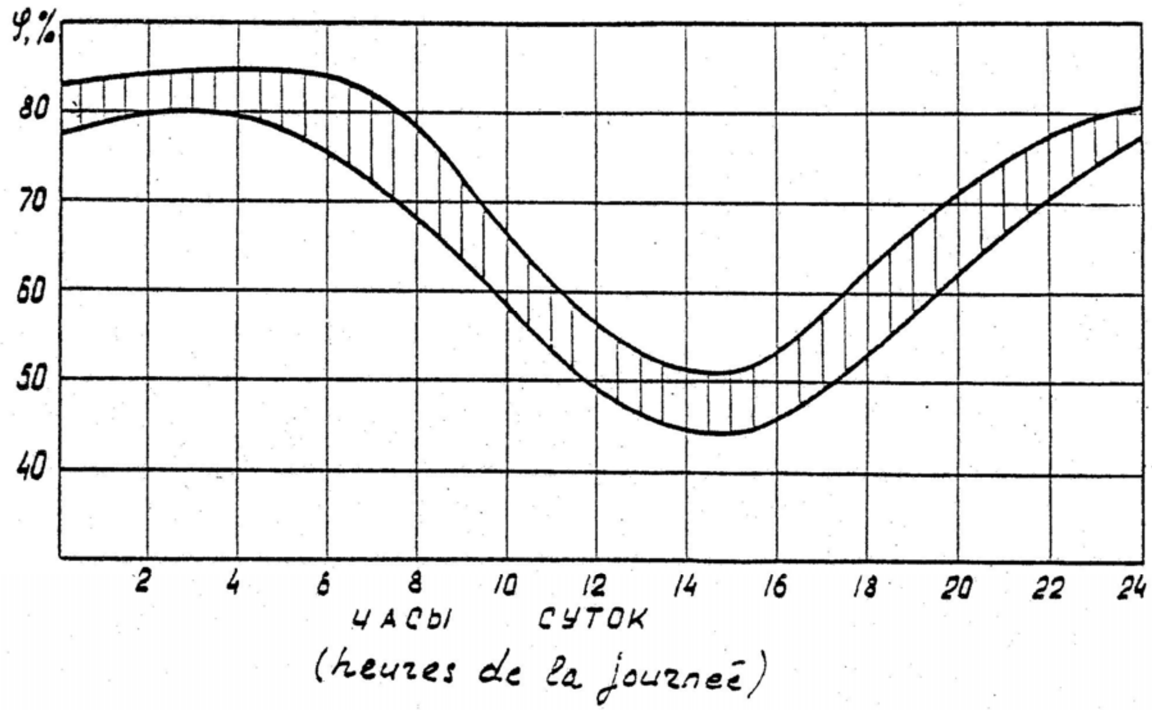

Figure 2. Models of daily relative air humidity variations during the period april to september in the Krasnodar area.

Relative Air Humidity

In Figure 2 a model of daily variations of relative air humidity during the growing period (April to September) is shown. Daily air humidity variations during the entire growing period do not exceed 10%.

Given that the sensitivity of regulating relative huimidity reaches 5%, a program for daily air humidity variations can be considered constant throughout the entire growth period and plant development. In the case of daily humidity variations exceeding the 10% limit, calculations of basic data for setting up a program are carried out in the same way as for temperatures.

Intensity of Radiation and the Photoperiod

Certain authors, such as I. A. Choulguine (3) believe that choosing a quantity of energy to assure maximal plant growth can be done using the daily means established over a great number of years per culture zone. In the case of an artificially lit culture, it is possible to determine an optimal value for radiations as the product of the intensity of I radiations by the length of lighting τ.

The daily quantity of radiation for a chosen area can be determined from these climatic models. For example, if one looks at climatic models for the Krasnodar area (1), one notes in the month of June the mean daily quantity of solar radiation is 2,38 kj/cm2 (370 cal/cm2) , the maximal value reaching 2,54 kj/cm2 (608 cal/cm2) and the minimal value dropping to 1,96 kj/cm2 (465 cal/cm2). Climatic models for radiations are presented in Figure 3. The zone which is found to be between the extreme values for radiations (shaded area) represents the limits within which new varieties should be tested.

Among all the mean and extreme values for total solar radiation, those of interest are in the physiologically active radiation zone (R Ph A).

It is possible to calculate approximately R Ph A values by using the method described by H. G. Tooming (2), Models for mean and extreme values of RPhA for the period April-September are given in Figure 3. In the month of June the total RPhA daily mean reached 1,153 kj/cm2 (272 cal/cm2), the maximum value being 1,263 kj/cm2 (298 cal/cm2) and the minimum being 0,975 kj/cm2 (229 cal/cm2).

In the growth chambers of Soviet origin of the KB-1 type, a RPhA irradiation of 200 wt/m2 is obtained at 0,15 meters from the protective glass. This irradiation represents a hour dose i of 17,2 cal/cm2.

From what has been written above, an optimal value for the photoperiod in a growth chamber can be calculated by using the following expression:

$$\tau = \frac{I}{i} = \frac{272}{17,2} = 15,8 \simeq 16 \text{ hours}$$

which corresponds to almost the length of one day in the month of June in the Krasnodar area. By analogy, the photoperiod for any area of the globe can be calculated.

Construction of a Climatic Program

In Table 1. The mean daily air temperature is shown for each month. In a natural environment, mean daily air temperatures vary throughout the month, as can be seen in Figure 4. For example, in the month of June, it increases from 19°C to 22°C, which means delta t mean = t30 - t1 = 3°C where t_1 is the mean air temperature on June 1st, t30 is the mean temperature on June 30. In other words, each day during the month "of June the air temperature increases by 0,1°C. It is clear that every air conditioned cabinet and chamber of the phytotron cannot guarantee such precision

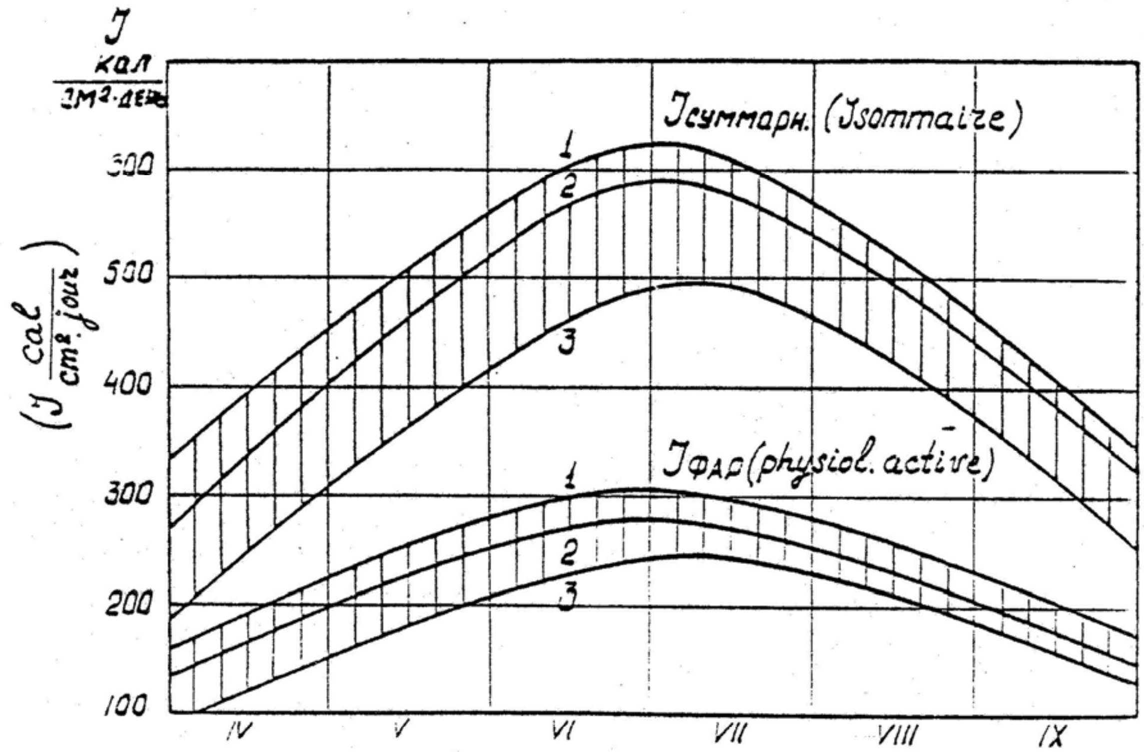

Figure 3. Models of global radiation variations and physiologically active radiations for the period april to september in the Krasnodar area.

1. Maximum radiation
2. Mean radiation
3. Minimal radiation

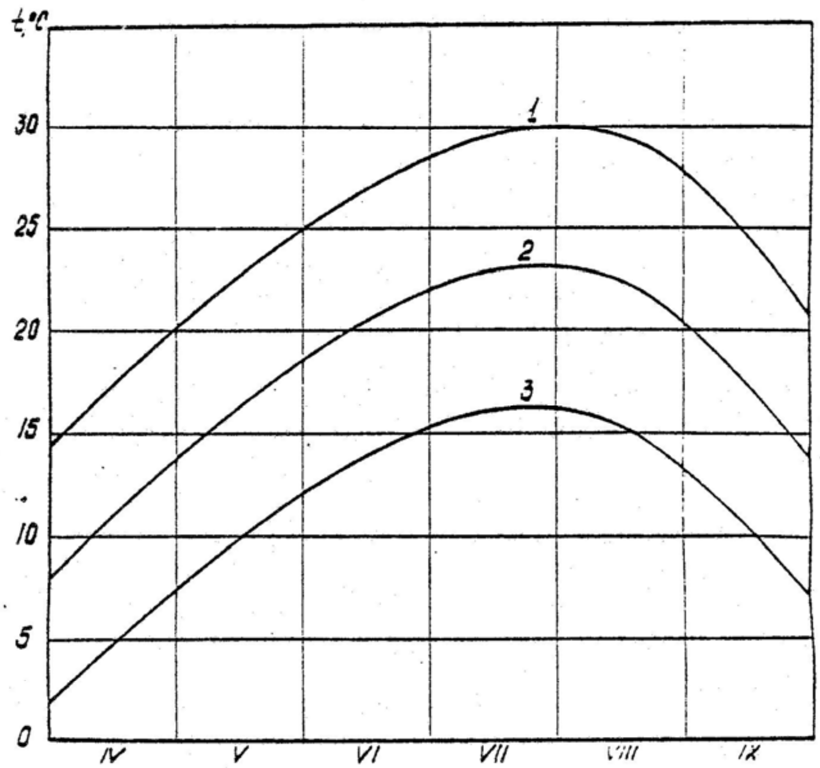

Figure 4. Models of air temperature variations during the period april to september in the Krasnodar area.

1. Maximum temperature
2. Mean temperature
3. Minimum temperature.

Table 1 (Part II). Daily Air Temperature Variations observed the 15th day of every Month from April to September in the Krasnodar Area

Time in hours	Month						
	1Y	Y	Y1	YII	YIII	IX	
1	7.4	12.5	15.9	18.6	18.2	12.6	
2	6.8	12.2	15.6	18.1	17.9	12.2	
3	6.4	11.9	15.3	17.8	17.5	12.1	Night
4	6.2	11.8	15.1	17.7	17.3	12.0	
5	6.1	11.7	15.1	17.6	17.1	11.9	
6	6.4	12.7	16.5	18.7	17.4	12.4	
7	7.2	14.4	18.6	21.1	19.7	13.5	
8	8.2	16.0	20.3	23.0	21.9	15.3	
9	9.9	17.4	21.8	24.5	23.8	17.4	
10	11.8	18.7	22.9	25.6	25.2	19.7	
11	13.5	19.5	23.9	26.7	26.3	21.4	
12	14.5	20.5	24.6	27.4	27.1	22.5	Day
13	15.5	21.1	25.1	28.0	27.7	23.3	
14	15.8	21.2	25.1	27.9	27.7	23.5	
15	15.6	21.2	25.0	27.8	27.7	23.2	
16	14.9	20.9	24.5	27.6	27.3	22.4	
17	13.9	20.3	24.1	27.1	26.6	21.0	
18	12.6	19.4	23.3	26.3	25.5	19.2	
19	11.3	17.9	21.9	24.8	23.5	17.5	
20	10.2	16.3	20.1	22.8	21.7	16.4	
21	9.7	15.2	18.8	21.3	20.6	15.6	Night
22	9.1	14.3	17.8	20.4	19.8	14.9	
23	8.6	13.7	17.1	19.7	19.1	14.1	
24	8.1	13.3	16.6	19.2	18.6	13.3	
24 hour mean Temperature (tm)	10.4	16.4	20.2	22.9	22.3	16.9	
Nocturnal mean temperature (tn)	8	13.3	16.5	19.1	18.8	13.7	
Day mean temperature (tj)	12.7	18.7	21.9	24.8	24.8	20.2	
tj - tn	4.7	5.4	5.4	5.7	6.0	6.5	

of air temperature regulation.Generally, precisions of air temperature regulation in such installations do not exceed ± 1°C. This is why in order to set up programs for mean air temperature variations, it is necessary to have variations of 1°C regularly throughout the month.

The number of periods depend from Δ tm, this indicate that the mean $\Delta_t = n$, where n is the number of program changes of temperature during one month.

The length of time for this period can be determined by using the following expression :

$$L = \frac{30}{n}$$

where 30 is the number of days in the month. For example, in the month of June , $n = \Delta t_m = 3$, so $L = \frac{30}{3} = 10$ days. After having drawn on the graph (Figure 5) mean air temperature variations , those for the day and night can be drawn by taking in Table 1 the difference $(t_j - t_n)$. For June $t_j - t_n = 5,4°C$.

It is preferable to transform fractional numbers into integers for setting up temperature programs. This is due to the fact that recording instruments for air temperature in chambers, as well as program selectors, are equipped with scales whose

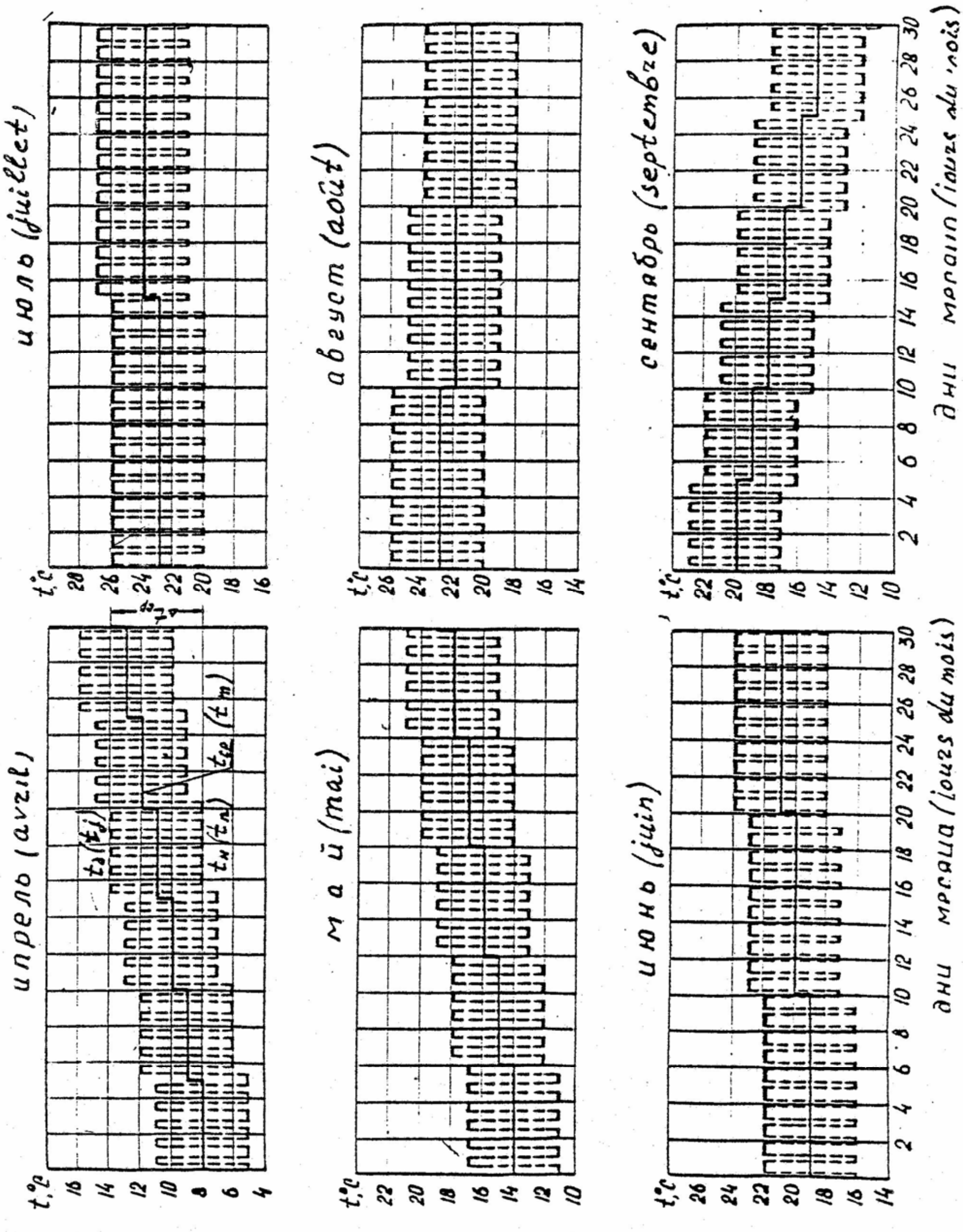

Figure 5. Climatic programs for the Krasnodar area.

value of division is 0,5 - 1°C. So, to make programmation easier, the difference of t, - t = 6°C is taken. Then, day and night temperatures are carried over on the graph, using "the following expression

$$T_j = t_m + \frac{t_j - t_n}{2}, \ °C$$

$$T_n = t_m - \frac{t_j - t_n}{2}, \ °C$$

where Tj and Tn are day and night air temperatures. In Figure 5 day and night air temperatures are represented by dotted lines.

Commutation of programs of cabinets, passage from day and night temperatures for a new regime are fixed for june at the 10th and at the 20th.

The length of time of photoperiods and nyctoperiods is determined from Table n°1. Photoperiod begins in the month of June at 4 a. M. and finishes at 8 p. M. At these hours the switching-over of nocturnal and diurnal temperatures of the air conditioned installation will be carried out. The duration of time of the light period and of the dark period are shown on the graph by solid Tines, which can be found above and below the line for; mean air temperatures.

In Figure 5 programs for the six months from April to September are shown. Using these graphs as a basis, the regulation of automatic programming instruments is carried out.

The method proposed for calculating and setting up climatic programs for growth chambers able to be used for research and breeding is one possible means of programming an artificial climate. It is obvious that methods of climate modelization in phytotrons will require improvements in the field of climate reproduction for various regions of the globe, as well as in the field of calculations and choising of optimal culture conditions for agricultural plants.

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XIV.-GROWTH OF CROP PLANTS UNDER HIGH LEVELS OF HID IRRADIATION IN THE WISCONSIN BIOTRON

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Introduction

Various combinations of cool white fluorescent and incandescent lamps have been extensively used for growing plants in controlled environments (Downs and Hellmers, 1975). One of the major problems with these systems *is* the inability to obtain the full range of incident energy fluxes that occur in natural environments. For this reason much interest had been shown in use of high energy discharge (HID) lamps, including mercury, metal halide, and high pressure sodium lamps (Bickford and Dunn, 1972; Duke et al. 1975; Warrington, Edge, and Green, 1978; Warrington et al., 1978; Tibbitts and Kozlowski, 1979).

Growth of plants has been shown to differ under various HID lamp combinations. Yet very little precise research has been done on plant responses under various HID systems and much more is needed. Duke et al. (1975) compared light intensity levels and growth of crop plants under metal halide (ME) and fluorescent-incandescent (FI) lamps. Under the higher light energy of the Z1H. system dry weight of plants over a 6-week period averaged 38% more than under the FI lamps. Initially the MH lamps reduced elongation of hypocotyls and cotyledons. Nevertheless, the MR system produced darker-green plants with larger leaves and thicker stems. Dry weight increment of soybean plants was increased by 33% under MH lamps but height growth was reduced by 33%. All plants grown under the MH system were sturdier and closely resembled field grown plants. Warrington, Mitchell, and Halligen (1976) studied plant growth under 4 combinations of lamps, including 2 types of metal halide, and one type each of coated mercury vapor and tungsten iodide lamps. Although all plants appeared to grow normally under each lighting system, differences in growth rate, plant form, and chemical composition were found. Temperature and irradiance levels also influenced growth but did not greatly after the relative responses obtained with the various lamp combinations. These experiments have now been extended to a study of vegetative and reproductive growth of 6 species of plants under a combination of sodium and multivapor lamps in the Wisconsin Biotron.

Methods

Five separate experiments of 28 days duration were conducted under 16 hrs of irradiance from 400 W sodium (Westinghouse) and multivapor (clear, Westinghouse) lamps in a 3:2 ratio that provided approximately 1000 uE sec^{-1} m^{-2} of irradiance at the container surface. Variables in the 5 separate studies were temperature, humidity, concentration of Fe and Mn, and form of nitrogen fertilizer as shown in Table 1.

Plants of lettuce (cv. Grand Rapids), marigold (cv. First Lady), tomato (cv. Oxheart), soybean (cv. Wells), snapbean (cv. Tendergreen), and corn (cv. W64 x W182 E) were grown in each study. Plant growth was measured at weekly intervals from seeding. All plants were grown in a commercial peat vermiculite mixture with automatic watering that applied a nutrient solution five times daily. Concentrations of nutrients applied are shown in Table 1. The nutrient additions were made at four hr intervals during a 16 hr light period, with the first addition at the start of the light period and the last one as the lights were turned off. Sizes of containers and nutrient additions are given in Table 2. The volumes of nutrient additions were calculated to provide a minimum of 50% (drainage) through the containers at each watering.

The experimental conditions monitored are given in Tables 3 and 4. Irradiance was monitored with a LiCor Quantum Meter LI*i.80 at the top of the containers or the top of the plant canopy. In Experiments 1 and 2, measurements were made only once. In Experiments 3-5, measurements were made weekly beginning at the start of the experiment. Air temperatures were measured continuously with a resistance sensor located outside the chamber and monitoring a sample of air drawn from three locations in the room area. This air reading was 2°C lower than the temperature monitored with shielded thermocouple sensors at the top of the containers. Soil temperature readings were taken 12-14 hrs after the start of the irradiance period with alcohol bulb thermometers inserted to the approximate center of each container at 7, 14, 21 and 28 days after planting in each experiment. Air humidity was monitored continuously with lithium chloride sensors, Hydrodynamics ≠/ 15-1810, located outside the chamber and monitoring the sample of air drawn from the room.

Data were obtained at 7-day intervals on plant height, number of leaves, and floral development. Plants were harvested at 28 days and dry weight of the plants, excluding roots, was determined.

All plants were harvested except that in Experiment 4, one plant of marigold, tomato, soybean and snapbean was maintained for flowering and fruit maturation to determine if seed could be produced under the high irradiance.

Seedling emergence time was similar in all experiments, with no more than one day difference in emergence in the various experiments. Emergence of lettuce required 3-4 days, marigolds 3-4 days, tomato 4-5 days, soybean 4 days, and corn 3 days.

Results

Plants grew quite effectively under the high irradiance in all experiments (Tables 5-8). Satisfactory seed production by tomato, soybean, and snapbean plants was demonstrated. Marigolds flowered but failed to set seed. Lettuce and corn plants were not maintained to flowering. All plants developed faster at air temperature of 25D: 20N than at I5D:20N. Most species produced larger and heavier plants with 70% RH. than with 40%. RR. Dry weight increase of lettuce was stimulated more by a 1/3 NH_4-N plus 2/3 NO_3-N fertilizer than by a fertilizer containing 100% NO3. However, the 1/3 NH4-N plus 2/3 NO3-N fertilizer was of little benefit to other species and appeared to inhibit dry weight increase of marigolds.

Specific problems with individual crop plants were the following:

Lettuce developed a much lighter green color under the HID lamps than under cool-white fluorescent irradiance. It also was slightly greener with NH_4-N fertilizer than without it. Tipburn was evident in Experiments 3, 4 and 5 at the higher temperatures.

Marigold plants grew vigorously and developed a deep green color in all experiments. As mentioned, flowers failed to set seed even though flowers were shaken to encourage pollination. Failure to set seed was also observed in other Biotron experiments under low irradiation.

Tomato plants were vigorous but tended to be light in color. They exhibited some epinasty in all experiments and the one plant maintained for seed production developed oedema (galls) on the under side of the leaves.

Soybean plants grew vigorously but had chlorotic leaves with pin point dark spots characteristic of Mn toxicity in Experiment 1. Reducing the amount of Mn in the nutrient solution in subsequent experiments almost completely eliminated the chlorosis . A large number of seeds set on the plant maintained for seed production. The plants had a bushy growth habit in all experiments.

Snapbeans grew vigorously but were slightly chlorotic in Experiment 1. Chlorosis was not evident in subsequent experiments with reduced Mn levels. Plants tended to exhibit a vine-type growth habit. This characteristic was pronounced and some lateral branches elongated as much as the main stem.

Corn plants grew vigorously but their leaves exhibited a Ca deficiency. The deficiency was apparent as soon as young leaves emerged. Ca deficiency was more pronounced at the higher temperature and most severe at the high temperature and low humidity. No answer is available for this problem but emerging leaves might be sprayed at daily intervals to provide the required amounts of calcium. Corn leaves also exhibited slight chiorotic streaking between the veins. Such streaking was effectively reduced by increasing the quantity of iron by 4x in Experiments 2-5.

Acknowledgements: The technical assistance of Beryl Nicholas is acknowledged.

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Table 1. Day and night temperatures, relative humidity and nutrient concentrations in high irradiation experiments.

Experiment	Temperature Light	Dark	Humidity	Nutrient Concentrations[a] N (meq/liter)	Mn (ppm)	Fe (ppm)
1	15°	20°	70%	7.5 as NO_3-	0.25	2.3
2	15°	20°	70%	7.5 as NO_3-	0.06	9.2
3	25°	20°	70%	7.5 as NO_3-	0.06	9.2
4	25°	20°	70%	5.0 as NO_3- 2.5 as NH_4+	0.06	9.2
5	25°	20°	40%	5.0 as NO_3- 2.5 as NH_4+	0.06	9.2

[a]Other nutrients in all experiments

meq/liter		ppm	
Ca	0.5	B	0.25
K	3.0	Zn	0.025
Mg	2.0	Cu	0.01
Ca	5.0	Mo	0.005
SO_4	2.0		
H_2PO_4	0.5		
cl	0.5		

Table 2

Experimental systems for high irradiation experiments

	Number of containers	Size of container	Plants per container	Nutrient addition Per day per container Weeks 1-3 (ml)	Week 4a (ml)
Lettuce	6	6" standard pot	1	250	500
Marigold	6	6" standard pot	1	250	500
Tomato	6	4.8 l polyethelene	1	750	750
Soybeans	6	4.8 l polyethelene	1	750	750
Snapbeans	6	4.8 l polyethylene	1	750	750
Corn	5	19 l polyethylene	1	2500	2500

[a]In the last experiment the additions were increased 50% for snapbeans and 13% for the other species.

Table 3 .—Atmospheric environment of high irradiation experiments

Experiment	Week	Irradiation ($\mu E\ sec^{-1} m^{-2}$)	Temperature (°C) Light	Dark	Relative humidity (%) Light	Dark
1	1		23.1	20.3	53	58
	2		15.4	20.5	58	63
	3	945	15.2	20.1	62	67
	4		15.5	20.5	59	65
	Mean	-	17.3	20.4	58	63.3
2	1		14.5	19.4	76	70
	2		14.2	18.9	77	71
	3		14.6	19.0	80	74
	4	910	15.5	19.2	88	83
	Mean	-	14.7	19.1	80.3	74.5
3	1	940	22.4	17.0	70	76
	2	945	25.5	20.3	63	69
	3	945	25.5	20.6	66	72
	4	940	25.4	19.9	63	69
	Mean	943	24.7	19.5	65.5	71.5
4	1	935	25.7	20.0	57	63
	2	925	25.6	20.1	61	67
	3	905	25.7	20.2	64	70
	4	920	25.5	19.9	62	68
	Mean	921	25.6	20.1	61	67
5	1	940	24.7	19.4	48	42
	2	950	24.5	19.4	45	39
	3	955	24.8	19.8	42	36
	4	960	24.9	19.7	41	35
	Mean	951	24.7	19.6	44	38

Table 4.— Soil temperatures in high irradiation experiments

Experiment	Week	Lettuce	Marigold	Tomato	Soybean	Snapbean	Corn
1	1						
	2		(No data taken)				
	3						
	4						
2	1		(No data taken)				
	2						
	3						
	4	20.5	21.0	20.2	21.7	18.0	18.2
3	1	28.7	29.1	29.4	29.9	29.7	29.1
	2	29.2	28.4	29.8	30.0	29.3	29.1
	3	28.3	27.6	29.1	28.8	27.1	28.8
	4	27.5	26.8	27.2	26.4	27.1	25.0
4	1	29.7	29.9	29.7	29.5	29.3	29.2
	2	28.4	27.0	29.0	28.1	28.7	28.8
	3	27.5	26.0	27.7	27.5	27.6	26.6
	4	26.5	26.3	25.6	25.8	25.5	25.6
5	1	28.3	27.5	28.7	28.1	28.8	28.1
	2	28.1	28.7	29.3	29.3	28.7	28.0
	3	27.8	26.3	28.1	28.1	26.6	26.3
	4	25.5	26.3	25.8	25.4	25.0	24.3

Table 5

Height (cms ± $s_{\bar{d}}$) of plants in high irradiation experiments

End of Week	Expt.		Lettuce[a]	Marigold[b]	Tomato[b]	Soybean[b]	Snapbean[b]	Corn[c]
1	1				(not available)			
	2				(not available)			
	3		2.2±0.3	2.8±0.3		2.8±0.8	4.8±0.4	16.4±1.3
	4		3.1±0.3	3.2±0.4		3.9±0.8	4.7±0.5	18.3±1.2
	5		2.1±0.8	2.6±0.4		3.1±0.3	5.1±0.4	16.5±1.3
2	1				(not available)			
	2		2.4±0.3	4.1±0.4		5.6±0.7	6.9±0.8	34.2±2.7
	3		4.5±0.2	5.5±0.6		6.7±1.0	9.0±1.4	48.8±2.9
	4		4.1±0.5	6.2±0.6		6.9±1.6	9.8±0.7	54.9±2.7
	5		4.4±0.3	5.3±1.3		6.6±0.7	9.0±0.8	46.5±1.3
3	1				(not available)			
	2		6.1±1.0	9.3±0.8		8.6±0.8	17.9±3.7	64.7±6.6
	3		12.3±0.6	13.5±1.5		13.3±1.4	28.8±6.0	90.5±4.6
	4		8.4±0.7	18.1±2.7		15.4±2.0	31.8±2.8	86.9±3.6
	5		8.4±0.4	13.3±1.7		13.7±1.3	29.0±3.7	87.1±4.0
4	1		9.5±1.4	18.7±3.0		13.7±1.8	38.6±12.1	99.1±8.0
	2	1.8±0.3	8.4±0.6	15.6±3.5		10.8±0.6	35.3±7.4	88.0±4.1
	3	2.8±0.4	13.1±0.8	35.5±5.2		26.6±2.7	44.7±13.9	141.5±4.4
	4	2.2±0.4	12.8±1.0	38.4±6.3		34.0±3.3	53.3±7.6	157.2±2.9
	5	3.3±0.4	11.5±0.7	32.4±4.0		26.8±2.3	41.2±7.8	130.4±5.7

[a]Length of stem from harvested plants only

[b]Soil surface to top of primary growing points

[c]Soil surface to tip of longest leaf extended vertically

Table 7

Dry weights of plants in high irradiation

Experiment	Lettuce	Marigold	Tomato	Soybean	Snapbean	Corn
			(grams ± $s_{\bar{d}}$)			
1	3.8±0.9	3.2±0.4	9.7±4.8	3.0±1.2	17.6±4.5	36.0±2.7
2	4.1±1.1	4.0±0.5	7.6±2.0	4.0±0.4	14.8±2.9	30.8±5.7
3	5.0±0.9	10.2±0.9	20.1±4.1	15.1±2.6	24.2±4.7	101.2±34,4
4	9.6±1.5	8.2±1.1	24.0±2.5	15.0±2.2	27.4±2.3	88.9±15,9
5	6.3±0.6	7.5±1.5	18.5±2.0	14.1±2.7	26.9±4.4	60.5±10,7

Table 6

Number (+ s_{-d}) of leaves[a] on plants in high irradiation experiments

End of week	Expt.	Lettuce[b]	Marigold	Tomato	Soybean	Snapbean	Corn
1	1			(not available)			
	2			(not available)			
	3			(not available)			
	4			(not available)			
	5			(not available)			
2	1			(not available)			
	2	6.2±0.8	4.0±0.0	3.0±0.8	2.3±0.5	2.5±0.8	5.4±0.6
	3	3.7±0.5	6.0±0.0	4.0±0.6	2.8±0.8	-	6.0±0.0
	4	5.2±0.8	5.7±0.8	4.1±1.0	2.8±0.4	3.0±0.6	5.4±0.6
	5	4.8±0.8	6.0±0.0	4.0±0.0	3.0±0.0	3.0±0.6	5.8±0.5
3	1			(not available)			
	2	9.3±1.7	8.0±0.0	7.2±1.0	4.6±0.5	5.3±1.0	8.0±0.7
	3	8.7±1.0	0.0±0.0	7.0±0.9	5.8±0.4	7.0±0.9	6.8±0.8
	4	13.8±1.9	8.8±1.0	7.7±0.8	5.8±0.4	6.7±0.5	9.8±1.3
	5	9.5±0.8	10.0±0.0	7.2±0.4	6.2±0.8	6.5±0.8	8.0±0.0
4	1	29.2±3.5	13.3±1.5	11.3±1.8	8.8±1.5	7.0±0.6	8.8±0.5
	2	26.2±3.9	11.0±1.3	11.0±0.8	6.7±0.5	5.7±0.8	9.4±0.6
	3	30.2±5.1	15.6±1.7	15.6±1.6	10.2±1.1	6.6±1.5	13.0±1.7
	4	52.0±7.4	15.2±1.2	15.2±1.5	10.7±0.4	7.0±0.6	12.0±0.7
	5	46.0±5.5	16.5±1.2	16.5±1.4	10.3±0.5	6.3±1.0	11.3±1.1

[a]Number of leaves over 1 cm in length

[b]Includes leaves on branches of secondary shoots.

Table 8

Floral development on plants in high irradiation

Experiment	Lettuce	Marigolds	Tomatoes	Soybeans	Snapbeans	Corn
1	None	None	No data	None	No data	None
2	None	None	Buds at 28d	None	Buds at 28d	None
3	None	None	Buds at 21d Flowers at 28d	None	Buds at 21d Flowers at 28d	None
4	None	None	Buds at 21d Flowers at 28d	None	Buds at 21d Flowers at 28d	None
5	None	None	Buds at 21d Flowers at 28d	None	Buds at 21d Flowers at 28d	None

XV.-DESCRIPTION OF A CONTROLLED ENVIRONMENT CUVETTE FOR DETERMINATION OP CO_2 UPTAZE

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Summary

A description is given of an artificial illuminated growth chamber which was constructed for determination of the net rates of exchange of CO2 between the foliage and the air under different environmental regimes, as net CO2 fixation has been considered as a measurable expression of the influence of environmental factors on plant production. Construction, function and operating range of the cuvette are described.

Introduction

Estimates of primary productivity of greenhouse planta have mainly been based on changes *in* dry weight over a period of time, using the destructive harvest method which precludes further investigations of possible changes in growth rate due to changes in development. A non destructive method has the advantage that the same plot of plants can be studied through. all stages of development, thereby eliminating any influence of morphological or physiological differences on photosynthetic efficiency. Furthermore, the method permits a more detailed examination of the diurnal variation in net CO2 uptake, which may lead to a better understanding of plant behaviour under different environmental conditions.

Since more than 90% of the dry weight of plants derives from CO2 assimilation, the rate of net photosynthesis has been considered a measurable expression of the influence of environmental factors on plant production. The use of CO2 fixation as an expression of the influence of a certain treatment is based on the hypothesis that the production of useful dry matter (DM) and the net photosynthetic rate (NPR) are positively correlated

$$\frac{d\ DM}{d\ NPR} = k \qquad (1)$$

and that the long term ratio

$$\frac{\text{useful DM}}{\text{total DM}} = \qquad (2)$$

does not change significantly as a result of the environmental treatment imposed.

Research on photosynthetic activity has for many years mainly been concentrated on single leaf behaviour-over rather short periods and at low light intensity compared with. light conditions. This important work should not he underestimated, as it has been indispensable in furthering the understanding of the complicated biological processes taking place in a plant at the cellular level. The results, however, very often have to be modified considerably before it is possible to apply then to the entirely different environmental conditions prevailing in a dense plant community with mutual Shading and uneven light distrihution through the canopy.

For economical and technical, reasons only few controlled environment cuvettes have been built large enough. to effectuate research on the influence of climatical factors on intact plants or plant communities. Temperature controlled cabinets built of transparent material, allowing natural light to penetrate, have the advantage of integrating the effect of diurnal variation in radiation flux density and short term fluctuations (known as "climatical noise") in the recorded results. On the other hand, artificially illuminated cabinets have the advantage that all factors - with the exception of the one investigated - can be maintained constant over any desired period of time and at any level within reasonable limits. Of the two different lit enclosures, one cannot be considered superior to the other, as both are useful tools and needed in order to conduct advanced research-work within the field of environmental horticulture.

Construction

The growth chamber described was constructed for determination of the net rates of exchange of CO2 between foliage and ambient atmosphere under different environmental regimes.

The cabinet **(1)** is made of stainless steel with a heat exchanger and a fan for internal air movement installed in an airduct (2) built into the hack wall. The heat exchanger is connected to a heating and cooling unit (33 controlled by means of a temperature sensor (PT 100) located in the air flow before the heat exchanger (x) ' The total floor area is 80 x 60 cm, of which 60 x 60 cm are available for the test plants, while the remaining area is occupied by the back wall airduct for recirculation of the enclosed air volume. The overall height is 80 cm with a perforated steel plate to support the plant containers 20 cm above the bottom.

The internal wind speed can be controlled over the range from almost zero to approximately 450 cm sec^{-1}. The direction of the air flow¯ is vertical so that all plants, when spaced uniformly, will experience a similar air temperature and movement of air past their leaves contrary to plants placed in a horizontal air flour, where the rows of plants on the inlet side might deflect the air stream and force the flow up over the canopy without changing the air ***mass*** between the plants. Also, a temperature gradient may occur across the cabinet, and even if the direction of **the** air flow may ***be*** reversed frequently, uniform temperature conditions might still not be achieved.

The vertical air movement has the disadvantage that it increases the temperature gradient within the canopy, as the shaded plant parts receive the cool air first. Also, the cool air stream may affect the root temperature if the plants are not cultivated in containers with independent temperature control. The difference between the air temperature measured below (at X2) and **above** the canopy (at X1), depends, at constant air velocity, on the heat toad (radiation) and has been found to range from almost 0 C in darkness to approximately 4 C at 500 watt m^{-2} shortwave radiation.

Using a zero balance method, the cuvette can be operated as a closed system, in which the enclosed air mass is constantly recirculated through the canopy, and only the net amount of CO2 detracted from the atmosphere by the photosynthetic process is replaced by CO2 from a cylinder. However, in order to avoid accumulation of undesirable gases, e. G. ethylene, during long term experiments, the enclosed air volume is normally exchanged 1-3 times h-1 by fresh air drawn from above the roof of the laboratory building, at which height the diurnal variation in CO2 concentration is negligible, as the building is located in an open agricultural area without polluting industry nearby. The fresh air is brought under pressure (4) before being passed through a coil placed inside a cooling tank (5) for dehumidicaeion. As condensation takes place under pressure, most of the water vapour can he removed from the air without using below-zero temperatures, as water content decreases proportional to increase in pressure (Dalton'e lace) under which the condensation takes place. By adjusting pressure and condenser temperature• the air flow can be dried to almost any desired level.

After passing a reduction valve (6) the air flow is measured by means of a thermal *flow sensor* (7) and - if required - mixed with additional CO2 in order to increase the CO2 concentration. The flow meter is not pressure dependent above the minimum pressure of 2 atm, but it is extremely sensitive to pressure changes, and the pressure vibrations in a normal reduction valve are sufficient to cause serious problems. Before entering the test room, the air passes a mixing unit (8).

Sant containers

The plants are grown in twin wall containers (9) with- an internal diameter and a height of 9.5 cm and 12 *am* respectively, allowing a root volume of approximately 850 cm3. From a temperature controlled tank (10) a liquid (water or alcohol) is circulated between the container walls in order to control root temperature independently of the *air* temperature. The root temperature can be maintained between -20°C and 40° C, and a high flow speed ensures an almost equal temperature in all containers, as the temperature difference between inlet and outlet is less than 1° C.

To obtain comparable results from different treatments it is *necessary* to supply . the plants with the same amount of water and nutrients at the same time. This is achieved by leading small tubes of black plastic over to each container, through which the nutrient solution drips from a tank (11). The surplus of water can, via plastic tubes, be drained to a collection tank- (12). The frequency and duration of the water application can be controlled by a time switch and a solenoid valve (13).

The containers can also be used for water culture experiments, if the nutrient solution from the collecting tank is pumped back into the supply tank (11). To similate greenhouse conditions, experiments can also be conducted with subirrigated plants in commercial pots placed on wet mats watered via the plastic tubes used for drip irrigation.

Evaporation from the soil is negiglible compared with transpiration, when the plant cover intercepts all the radiation. However, if the soil surface is not under complete cover of foliage, evaporation can be appreciable. It is almost impossible to seal off the soil surface completely, but if the containers are covered with. A 20 mm thick *circular* polystyrene plate with a central opening for the stem, it has been found possible to reduce evaporation to only 7% of that from uncovered containers, even when the plate was lifted 10 mm above the container surface in order to get free air access to the soil surface.

In preliminary transpiration experiments the containers were placed in plastic bags whichewere tied tightly at the neck. around the stemet however, after 3-4 sours the transpiration rate decreased, but could be restored by opening up the plastic bags•for an hour. Determination of ODR. by means of platinum electrodes, as described by Kriatelmen (196.6) , suggested that the. decrease in transpiration rate could be ascribed to oxygen deficiency. The soil surface cannot therefore be completely sealed off, and consequently a limited amount of C_2, produced by microbiological activity in the compost, will enter the enclosed atmosphere and reduce the measured net photosynthetic rate. The average production of CO2 from the decomposition of compost has been estimated to be 2.2 mg CO_2 h^{-1} per container. Although such production will depend upon the environmental conditions, it is presumed unnecessary to measure the rate at which. Soil produces CO_2, because production will remain almost constant under the constant conditions in the cuvette. As the principal aim is normally to find the slope of the response curve to an applied treatment or to find the optimal factor values rather than to determine the CO2 fixation in absolute terms, disregarding this small component of CO2 from microbial activity will not most experimental results.

Light sources

The growth room is illuminated with Philips high pressure mercury halide lamps, HPI/T (U. K. designation MEI/H), which can provide a maximum radiation flux density at plant level of approximately 700 wm^{-2} short wave radiation (300-3000 nm). The HPI/T lamps have proved to be a suitable light source for plant growth in controlled environment experiments; plants illuminated by this type of lamp developed naturally in all respects, even over long periods of only artificial illumination. The high pressure sodium lamp, SON/T, has demonstrated an approximately 15% higher efficiency on photosynthetic rate than the HPI/T lamps, but no long term experiments have been conducted.

The lamps are installed in a ventilated lamp cabinet (14), separated from the test room by a twin layer thermal pane. Controlled ventilation of the lamp cabinet main tains an air temperature of 33-34›C , and electrical air heaters ensure the same temperature during the dark periods in order to prevent condensation on the pane.

Measurements of CO2 uptake

In order to measure the net CO2 uptake from the canopy in the enclosure, air samples are continuously drawn from the recirculation air duct in the growth chamber (2) and water vapour removed by passing the air flow through a coil placed inside a cooled water tank (15). The CO2 concentration is compared with the concentration in the inlet air by means of an infra-red gas analyser (16) equipped with a differential cuvette using the inlet air supplied to the test chamber as reference gas. As the inlet air is dried under pressure it might have a lower dew paint than the air sample drawn from the test roam and dried under normal pressure in (15). In order to eliminate this effect the reference gas drawn from the inlet air pipe passes a humidifier (17), bringing the dew point to a proximately the same level as in the cabinet before being passed to (15) and dried to exactly the same dew point as the test gas. The output from the CO2 analyser directs, by means of a PI controller (18), the CO2 supply from a cylinder (19) to the growth chamber so that the CO2 concentration in the growth chamber (Cl) is maintained equivalent to the inlet concentration (C2). The amount of CO2 added to the atmosphere in the enclosure in order to make

$$C_1 - C_2 = 0$$

is equivalent to the net amount of CO2 taken up by the canopy. The CO2 flow is metered by a Brooks flow meter (20) and recorded on a punch tape recorder (21) for computation.

Data recording

A single treatment normally proceeds for 60 minutes, during which. Period parameters necessary for the interpretation of the results. are recorded at one-minuje intervals. The total short wave radiation is measured with. A Kipp and Zoonen solarimeter placed at the upper canopy surface. The photosynthetic active radiation is measured with. A Li-Cor light sensor placed at the same position *as* the solarimeter.

Air temperature is measured with a resistance thermometer placed in the air duct above the fan (at xi). Leaf temperature is measured with_ iron constantane thermo couples inserted from below into the upper leaves with a reference junction placed in the air due next to the thermometer measuring the air temperature. Ideally, the temperature, which. should be known and controlled, is that of the plant, but canopy temperature is very difficult to define. When radiation strikes a plant, the foliage temperature increases, but in an irregular fashion, depending on position in the canopy and on physiological and morphological differences. The temperature of suc culent leaves and fruits will rise more than the temperature of thin leaves when exposed to the same radiation flux density. Consequently, leaf temperature in absolute terms cannot be obtained by means of inserted thermocouples, although relative values illustrating the temperature levels under different treatments will, in most cases, be sufficient. An integrated canopy temperature can be achieved by means of infra red radiation thermometers, but none of the tested types have yet proved to be suitable for temperature control in growth chambers.

Plant material

The size of the growth chamber restricts the type of plants, which can be employed in the experimental work, but as house plants are the most important greenhouse crop in Denmark, there are good reasons for using commercial type pot plants in the research projects. The plants are precultivated in standard peat compost in a modern greenhouse and transferred to the growth chamber for acclimatization at least 24 hours before starting the experiment. Preliminary measurements have shown that the plants have a lower rate of net CO_2 uptake the first day after transfer to the growth chamber compared to subsequent days, even when the temperature level is identical to the greenhouse temperature under which the plants have been previously cultivated.

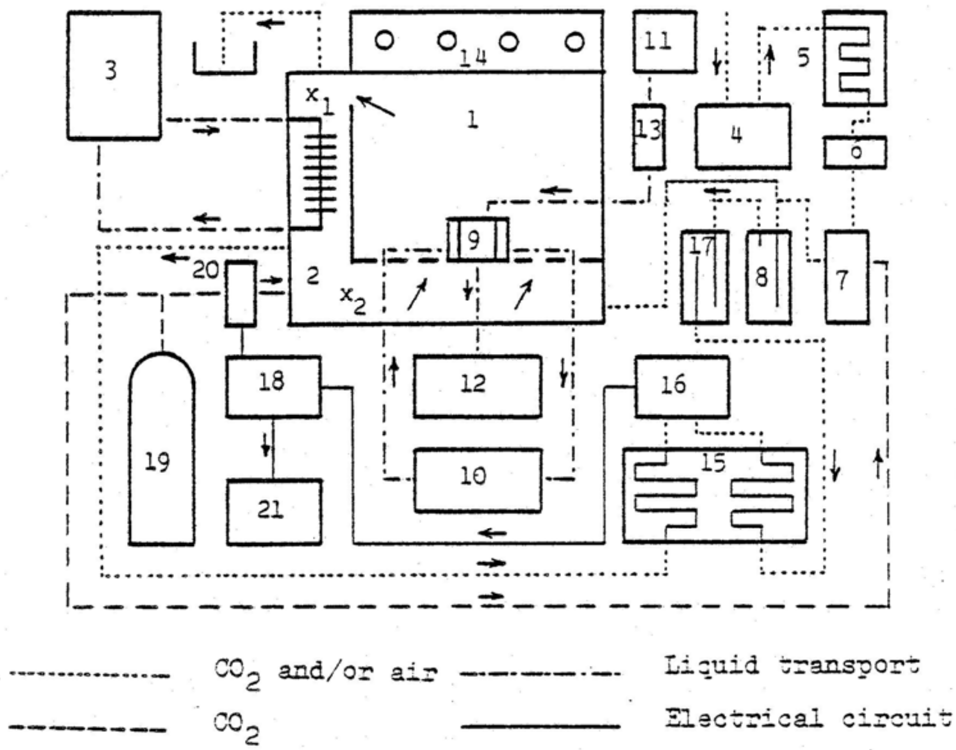
Since the plant canopy is a rather heterogenous assemblage of leaves with differences in anatomy and structure which effects photosynthetic efficiency, experiments must necessarily comprise a reasonable number of intact plants, spaced in a way comparable to commercial practice, in order to obtain reliable results expressing the response of a normal plant community.

Limitations

A limitation of the method using CO_2 uptake as a measurable indicator for a possible influence of a certain treatment is that the photosynthetic rate only expresses the influence on dry matter production, but gives no information about distribution in the different organs. Furthermore, the experimentally determined CO_2 exchange rate only expresses the immediate influence of a treatment as it is determined on the same leaf area and does not include the leaf area expansion resulting from the treatment over a period of time. In order to predict the real impact of a certain treatment on actual plant production over a period of time, the metered results must be corrected. If useful dry matter production is considered a linear function of net CO_2 uptake, the effect of a treatment over a period of time will be an experimental function of the immediate uptake (Andersen 1976).

Another problem , which_allpies to all short term experiments, is the possibility for a temporary carry-over effect from the previous treatment.

In many cases one hour is sufficient time between treatments, to ensure that a new steady state has been established. More serious are the permanent or long lasting adaptation phenomena as reported by Downton and Slatyer (1972) or diurnal variations independent of the environment.



LEGEND

		11	Nutrient solution tank
1	Growth cabinet	12	Drainage collection tank
2	Airduct	13	Solenoid valve
3	Heating and cooling unit	14	Lamp cabinet
4	Compressor	15	Dehumidifier
5	Dehumidifier	16	Infra red gas analyser
6	Pressure reduction valve	17	Humidifier
7	Thermal flow sensor	18	P I controller
8	Air mixing unit	19	CO2 pressure cylinder
9	Twin wall plant containers	20	Thermal flow meter
10	Heating and cooling unit	21	Punch tape ¯recorder.

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XVI. - SELECTION OF LOCATIONS FOR SENSORS OF ARTIFICIAL CLIMATE MEASURING AND CONTROL SYSTEMS

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Selection of locations for sensors of artificial climate measuring and control systems significantly affects the control performance of maintaining microclimate parameters in rooms. In this respect, of the most distinctive controlled members are phytotron premises with their space distribution and time variation rate of air parameters being highly dependable not only upon a type of fresh air distribution in premises but also on indoor heat-and-humidity liberations and on a perturbing influence of ambience.

In Ref.!, there are shown the results of an experimental investigation of the dynamic equations for an air-conditioned vegetable storehouse that display the dependance of the numerical values of the controlled member time constant and of the controlled parameters upon the locations of corresponding sensors. The above dependance proves that a technique for determining sensor locations is to be developed which meets strict requirements in stabilization of parameters at a predetermined level in the entire volumes of premises.

In determining locations for sensors, statistical methods of investigation of the controlled parameter interrelation with various disturbances are most preferable, sinse the space distribution of parameters depends upon a type of air distribution and on random external and internal disturbances.

At any point of a controlled room volume, the occilating process of a controlled parameter y(t), being near its set value determined by a corresponding setter of the regulator, can be characterized by a dispersion D caused by a variation of a corresponding fresh air parameter x(t) and by t1¯1 action of disturbances (indoor heat-and-humidity liberations and the influence of ambience). For this case

$$D = D'_y + D''_y , \qquad (1)$$

where D' and D" are the components of a combined dispersion which are dictated by, respLtivelyT a variation of the parameter x(t) and the action of disturbances.

For a sensor to be located in, a typical point of the controlled room volume is to comply with a spatially averaged magnitude of the component D''_y resulting from both the presence of heat-and-humidity liberations and the influence of ambience. With the sensor located as indicated above, the controlled parameter gets best stabilized. Yet, it is practically impossible to determine the component D" in every controlled point, sinse the magnitude D_y depending upon both the action of disturbances and the parameter x(t) is the only one which can be measured or determined.

But the component D can be determined indirectly, that is, by employing a correlation ratio η_{yx} of the controlled parameter y(t) to the fresh air parameter x(t) determined trom the well known expression

$$\eta_{yx} = \sqrt{\frac{D'_y}{D_y}} = \frac{1}{n\sigma_x\sigma_y}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}), \qquad (2)$$

where n is a number of simultaneously taken measurements of the parameters x(t) and y(t), X_i and y_i are the results of the i/x measurement of the parameters x(t) and y(t), $\overline{X}$ and $\overline{y}$ are mean magnitudes of corresponding parameters, and σ_x and σ_y are quadratic-mean deviations of these parameters.

On the analogy of the expression /2/, there can be given a correlation ratio that characterizes the relation of the controlled parameter y(t)to the action of disturbances:

$$\eta_i = \sqrt{\frac{D''_y}{D_y}} = \sqrt{\frac{D_y - D'_y}{D_y}} = \sqrt{1 - \frac{D'_y}{D_y}} = \sqrt{1 - \eta^2_{yx}} \qquad (3)$$

With consideration for the expression /2/, the equation /3/ makes it possible to determine the variations of a room microclimate, caused by internal and external disturbances, the determination being effected on the basis of the data about both the corresponding parameter y(t) in its measuring point and the fresh air parameter x(t) of the air-conditioning plant, that is similar to the former.

The correlation ratio η_1 is used here to denote the characteristic ratio of a given point of the controlled room volume. According to the foregoing condition of selecting a characteristic point, the characteristic ratio for the location for a sensor of the regulator should meet the requirement described by the expression

$$\eta_x = \frac{1}{m}\sum_{j=1}^{m} \eta_{1j}, \qquad (4)$$

where m is a number of points of the controlled room volume with determined magnitudes of η_i.

Proceeding from the above, the algorithm of determining a characteristic point may be formulated in the following way:

1. At specified intervals of time that are defined with the help of generally known recommendations for determining the mathematical expectation and the random process dispersion, we take in various points of the volume of a given room the measurements of the parameter y(t) and, simultaneously, the measurement of the fresh air parameter x(t).
2. Then we determine the magnitudes of η_1 for each control point in conformity to the equation /3/ with consideration for the expression /2/.
3. Next we determine the magnitude of η_x which corresponds to an averaged value of dispersion depending upon the action of disturbances. (Expression /4/).
4. The point with the magnitude of η_i which is closest to the calculated magnitude of η_x we select as the location for the sensor of the microclimate control system of a corresponding parameter.

It is to be noted that the greater number of points in the volume of a controlled member is processed with the aid of this algorithm the more accurately the characteristic point is located.

The proposed algorithm was experimentally tested on microclimate control systems of greenhouses and artificial fibre factories. There was observed that the temperature dispersion in an air-conditioned room rises, depending on a type of air distribution and the character of process in the room 1.5 to 2 times if the sensor of the temperature regulator *is* located in a 5-m distance from the sensor location defined by the algorithm. This bears witness to the necessity of a preliminary investigation of the controlled member for the purpose of determining the sensor locations providing for averaging the action of disturbances.

In conclusion it should be said that the proposed algorithm for determining characteristics points may be used not only for selecting locations for sensors of microclimate parameters but also for determining characteristic points for controlling CO_2 concentration systems. The universality of the algorithm in question makes it possible to employ it for determining the characteristic points of any distributed controlled member which is liable to drastic random disturbances and requires an evaluation of its condition and a corresponding control.

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XVII - LABORATORY MATERIAL

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Measure photosynthetically active radiation (PAR): Radiation in the 00-700 nm wavelength.

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Ranges. Zero to : (ranges only, not conversion factors)

microeinsteins* $m^{-2}s^{-1}$	watts m^{-2}	lux**	millivolts
3	3	30	3
10	1	100	10
30	3	300	30
100	10	1000	100
300	30	3000	300
1000	100	1×10^4	1 volts
3000	300	3×10^4	3
1×10^4	1000	1×10^5	10
3×10^4	3000	3×10^5	30

* 1 microeinstein = 6.02×10^{17} photons. Daylight quantum flux measurements at solar noon are typically about 2000 microeinsteins $m^{-2}sec^{-1}$.
** 10.764 lux = 1 foodcandle.

Li-170 Quantum/Radiometer/Photometer

Ranges, zero to (ranges only, not conversion factors)

microeinsteins*	watts m^{-2}	lux (10.764 lux = 1 footcandle)
200	20	2.000
2.000	200	20.000
20.000	2.000	200.000

* 1 microeinstein = 6.02×10^{17} photons. Sun plus sky PAR quantum flux measurements at solar noon are typically around 2.000 microeinsteins $m^{-2}s^{-1}$.

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Low cost

Ranges	Quantum	Radiometer	Photometer	Voltage	Current
X 1000	0-19990 $\mu E\ s^{-1}m^{-2}$*	0-1999 watts m^{-2}	0-199900 lux**	0-19.99 volts	0-199,9 μA
X 100	0-1999	0-199.9	0-19990	0-1.999 volts	0-19.99 μA
X 10	0-199.9	0-19.99	0-1999.	0-199.9mvolts	0-1.999 μA
X 1	0-19.99	0-1.999	0-199.9	0-19.99mvolts	0-199.9 nA
X 1	0-1.999	0-.1999	0-19.99	0-1.999mvolts	0-19.99 nA

The above are not conversion factors from one type of measurement to another

* Unit currently in use are photons, moles and einsteins 6.02×10^{17} photons $s^{-1}m^{-2}$ = $1 \mu mol\ s^{-1}m^{-2} \equiv 1 \mu E\ s^{-1}m^{-2}$
Full sun plus sky PPFD is = $2000 \mu mol\ s^{-1}m^{-2}$ or $2000 \mu E\ s^{-1}m^{-2}$.
** 10.764 lux = 1 footcandle.

7) Total and Average Data during a Measurement period

Solar Energy PAR (Photosynthetically Active Radiation), Temperature, Voltage or Current

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Total and average information from the voltage or current output instrument of your choice.

Li-550 Printing Integrator

Totals printed - 1 min, 10 min, lhr, 24 hr.

Li-510 Integrator (electronic display)

Weather Resistant, Oust Sealed, Humidity Controlled, Battery Powered

8) Preliminary product Information

System Features

Pyranometer performance approaching 1st class thermopiles at 1/10 the cost as substantiated by government laboratories (NOAA, Seri).

Precisely calibrated to an Eppley PSP under clear daylight conditions

Highest quality silicon photovoltaic detector - not inexpensive solar cells

Fully cosine corrected - 1% linearity error - weatherproof sensor

Small size pyranometer - ideal for use in solar collectors and remote areas

Integrated and instantaneous measurements - rugged pyranometer - 0 tilt error

Temperature independent circuitry and sensor.

9) Autoporometer

Automatic Diffusive Resistance Meter

Measures leaf resistance to water vapor diffusion

Li-65 Autoporometer

Automatic timing, Brief leaf contact, Minimum effect on stomata, Display visible in sunlight, Direct temperature readout, Convenient carrying strap, Batter* life 1500 cycles, D cell powered.

10) Steady State Porometer An

instrument for to day.... and beyond.

Inherent Standard, Calculates Diffusive. Resistance (sec cm^{-1}), Eliminates Calibration Plates and Curves, Measures True Leaf Temperature, Flexible, Aperture or Chamber Applications, Nulls to Ambient Humidity, PAR measurement capability, Computer Compatible, Wide range (0.5 to 100 sec cm^{-1}), Stable humidity sensor, Minimum interference of incident radiation, Cuvette temperature maintained at ambient, No gaz bottles required, Interfaceable to datalogger, Microprocessor based, Semi-Automatic nulling, Rechargeable battery.

Measurement (direct)	Units	Accuracy
Diffusive Resistance	sec cm^{-1}	10%
Transpiration	$\mu g\ cm^{-2}s^{-1}$	6%
Relative Humidity	%	3%
Leaf Temperature	degC	.35 deg C
Chamber Temperature	degC	.25 deg C
Flow Rate	$cm^{-3}\ sec^{-1}$	5%
PAR (optional)	$\mu E\ s^{-1}\ m^{-2}$	5%

Editor's Note. From the letter published in 1979 by Li Car and addressed to all Scientist we reproduce only few important passages about units and terminology for measurement. Those who want to receive more information please write directly to LI Cor Inc. (4421 Superior Street PO Box 4425. Lincoln Nebraska 68504 USA) because in this letter one can read following conclusions:

Your comments on the subjects addressed in this letter or any other measurement problems are always welcome and will be treated as valuable inputs.

Dear Scientist,

We would like to take this opportunity to "englighten" those involved with photosynthesis radiation measurement on the current state of "flux" concerning units and terminology, some often overlooked measurement errors, and some information on converting units. Also, we would like to inform you that we have changed our name from Lambda Instruments Corporation to Li-Cor, inc. The change is in name only. All officers, stockholders and facilities remain the same.

Units and Terminology

There is disagreement concerning units and terminology used in radiation measurements in conjunction with the plant sciences. It will be Li-Corks policy to adopt the recommendation of the international committees, such as the Commission Internationale de l'Eclairage (CIE), the International Bureau of Weights and Measures and the International Committee on Radiation Units.

Units

The einstein as a unit to designate Avogadro's number of photons is under controversy. It has been suggested that this quantity be expressed in units of moles {Incoll et al. Current Adv Plant Science 1977, 9, 331-343). The einstein has been used to represent both the quantity of radiant energy in Avogadro's number of pho tons and also Avogadro's number of photons. When the latter definition of einstein is used, the quantity of photons in a mole is equal to the quantity of photons is an einstein as shown in the equality : 1 einstein == 1 mole = 6.02×10^{23} photons.

Terminology

Li-Cor is following the lead of the Crop Science Society of America, Committee on Terminology (Shibles, Crop Sci 1976, 16, 437-439) until international committees put forth recommendations. We have introduced the term PPFFR (Photosynthetic Photon Flux Fluence Rate). Oceanographers and limnologists have sometimes called this Scalar Quantum Irradiance. From our correspondence with the CIE, it seems more likely that the term photon flux fluence rate will be adopted.

-PAR (Photosynthetically Active Radiation) is defined as radiation in the 400 to 700 nm waveband, PAR is the general radiation term which covers both photonterms (Mc Cree, Agric,Meteorol.1972, 10, 443-453) and energy terms.

–PPFD {Photosynthetic Photon Flux Density) is defined as the photon flux density of PAR. This is the number of photons in the 400 to 700 nm waveband incident per unit time on a unit surface. The ideal PPFD sensor responds equally to all photons in the 400-700 nm waveband and has a cosine response. This physical quantity is measured by a cosine quantum sensor such as the Li-190S, Li-191S or Li-1925.

Units : $1 \mu E\ s^{-1} m^{-2} \cong 1 \mu mol\ s^{-1} m^{-2} \cong 6.02 \times 10^{17}$ photons $s^{-1} m^{-2}$

-PPFFR(Photosynthetic Photon Flux Fluence Rate) is defined as the photon flux fluence rate of PAR. This is the integral of photon flux radiance at a point over all directions about the point. PPFFR is the same as PPFD for normal incident collimated radiation and it is 4 times that of PPFD in totally diffuse radiation. The ideal PPFFR sensor has a spherical collecting surface which exhibits the properties of a cosine receiver at every point on its surface and responds equally to all photons in the 400-700 nm waveband. This physical quantity is measured by a spherical (417collector) quantum sensor such as the Li-193S.

Units : $1 \mu E\ s^{-1} m^{-2} \cong 1 \mu mol\ s^{-1} m^{-2} \cong 6.02 \times 10^{17} photons\ s^{-1} m^{-2}$

PI (Photosynthetic Irradiance) is defined as the radiant energy flux density of PAR. This is the radiant energy (400-700 nm) incident per unit time on a unit surface. The ideal PI sensor responds equally to energy in the 400-700 nm waveband and has a cosine response. This physical quantity is measured by a cosine PI sensor such as the Li-190SE, Li-191SE or Li-192SE.

Units : watts m^{-2}.

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NEW BOOKS.

A.-LA PHYSIOLOGIE DE LA FLORAISON

International Colloquium of CNRS. Gif/Yvette . France (1978)
Edited by CNRS. 15 Quai A. France. 75007. PARIS France. 1979. 244 pages

The International Colloquium of CNRS on the Physiology of Flowering, held at Gif/Yvette in July 1978. About 80 leading plant physiologists,from various countries, participated in plenary sessions and special work shops seeking to discuss recent results and to develop a new strategy for the research in this field. They examine various hypothesis, models and methods now available for the approach of the exceedingly complex problem of plant flowering.

This volume "La Physiologie de la Floraison" wrote in english contains the final reports produced by the discussion groups, which survey the present state of knowledge in the following topics presented by presidents of each session:

J. KREKULE. Stimulation *and* inhibition of flowering: morphological and physiological studies J.

A. D. ZEEVAART. Perception, nature and complexity of transmitted signals

D. VINCE PRUE. Effect of photoperiod and phytochrome in flowering: time measurement G.

BERNLER. The sequences of floral evocation

R. SACHS. Metabolism and energetics in flowering

J. PERNES. Genetic systems involved in the flowering process.

9.-LA FORET FRANCIUM

G. Plaisance. Edition Denoel. 19 rue de l'Universite, 75007. Paris. 1979. 373 pages.

This very interesting book is written by a specialist of forestry who loves forests. It is a book for all those who like nature and want to know it with more details.

The description, written in narrative style begins by history of French forests, the description of trees and peoplings, a rapid study of the forest, and various possibilities of looking at the forest by many kinds of ways : scientific , ecologic, geographic farming, energetic etc....

The recreative forest, its environment, its values for education, hygiene, and touristic , precede the study of management means and also other functions more known : wood production, soil protection and hydrological regulations.

Several pages about animals, hunt, depredators and diseases are completed by utilitarian point of view: replanting, production of wood and economical aspects of the forest without forgetting the study of the future of the forest and wood in France.

This study continues by a glimpse on country organization and monographs of several old forest; well known and situated in various parts of France.

With many useful informations added in annex , this book written in alert and vivid style is also a very useful source of informations and remarks for everybody. It will easily find its place in any library not only specialized in forests nor french library but also in many countries for scientific and technical aims.

PROTECTED CULTIVATION IN POLAR ZONE

G. Z. Berson. Edited by "Kolos" Moscow (USSR) 1979 - 205 pages

This book with many informations set over all aspects of cultivation in polar zone particularly in the Permafrost. Necessity of this culture was born from the deficiency of vegetables and fresh fruct in alimentation, specially in certain vitamines (C-81-PP-B6 and 0). Moreover, the existence of subteras/ean hot water has permite the installations in this cold regions of USSR more than 40 Hectares of glasshouses, 25 Has of plastic sheiters and 20 Has of hotbeds, parallelly to the arrival of pioneers of petroleum indusrry and its development in these regions.

Average produces by square meter are interesting : 28-38 kg of cucumbers during the winter and 22-32 Kg in spring.

This book treates successively:

- Ecological conditions and principles of construction of greenhouses at those latitudes
- Peculiarities of protected cultivation: soil heating and hot beds
- Greenhouses with their particularities of installation: means of protection against accumulation of snow on wall sides, means and sources of heating with indication of special imperatives to be respected.
- Artificial lighting of plants in greenhouses: sowing, total lighting of plants and complementary lighting during short days period
- Substrata utilized, various mixtures , artificial substrata turi-and duration of rektilisation, hydroponics
- Cucumbers cultivation: biological peculiarities, varieties, manure, technic peculiarities for winter cultivation, qualities of nutritional mediums

- Tomatoes cultivation : biological peculiarities, varieties, manure, technic peculiarities, containers' cultivation, growth stimulators.
- Market plants cultivations: onions, beets, celeries, parsleys, chicories, sorrels etc.
- Annual vegetables cultivations: radish, lettuce, spinage, dill etc.
- Survey of protected cultivations, Prophylactic, methods of surveys, substratum desinfection,plants protection
- Economic pecularities, agroeconomical appreciations income, perspectives of future development, possibilities of reducing prices.

This book of great interest presents a great fault : no chapter has summary in any language other than Russian; for this reason it is practically inutilizable for large diffusion out of USSR.

D - CONTROLLED ENVIRONMENT GUIDELINES FOR PLANT RESEARCH

Edited by T. W. Tibbitts and T. T. Kozlowski Academic Press Rapid Manuscript Reproduction 1979 New York. 413 pages (III Fifth Ave NY 10003. New York USA).

The volume brings together information presented at the Controlled Environments Working Conference held in Madison, Wisconsin, March 12-14 1979.

The guidelines proposed include recommendations for regulating and measuring such environmental factors as radiation, temperature, carbon dioxide, atmospheric moisture, soil moisture, and air movement in controlled environment facilities. They suggest how measurements can be made accurately and in ways that can be repeated by other investigators.

The book is intended for biologists and engineers using controlled environments with a view toward ensuring precise and reproducible research. It should also be useful for investigators undertaking environmental measurement and control in greenhouses and in the field.

The papers were presented by invited plant physiologists, physicists and engineers of demonstrated competence.

Contents:

E. MODELIZATION OF PRODUCTIVITY AND COLD RESISTANCE OF PLANTS

V. K. Kuretz and E. G. Popov. Edited by "Nauka" Leningrad USSR 1979. 160 pages, 20 tables, 73 figures and 183 bibliographic titles.

This very interesting book, unfortunately written in Russian without any summaries in other languages, is a monography of planification methods ***and*** realization of plurifactorial essays which permit to obtain rapidly the equations with connexions (models) between : intensity of plant apparent photosynthesis with climatic factors, and also plant resistances to low temperatures. Models obtained by multifactorial experiences can be utilized for production of plant protected cultivation for estimation the damages caused to the plants by low temperatures and also to hasten breeding and genetical work with plants.

In this book authors describe air conditionned installations for modelization of environmental factors and give several basis of plant ecology, specially for specialists, non biologists, but interested by plant modelization.

Table of contents is:

Chapter I. Environmental factors and their influence on plant productivity: Light, Soil and air temperature- Water - Climate pecularities in protected cultivation-Wind-Influence of environment on intensity of CO2 assimilation.

Chapter II. Modelization of environmental factors: existing installation of artificial Climate. Cultivation for special use of modelization experiences.

Chapter III. Multifactorial experiences: Methods for their efficacy - Means to oriented photosynthetical productivity of plants and models of productivity .

Chapter IV. Models for cold resistance of plants. Statistical models of cold resistance of plants. Modelization of resistance in hermetical phytotron. Analogical modelization.

F.LISTE DES LIVRES SIGNALES - NEW BOOKS

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Copies can be ordered from the Secretariat of the Society : Bezuidenhoutseweg 73
PO B 20401. 2500 EK. The Hague. The Netherlands.

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XX - COMING EVENTS, MEETING AND EXHIBITIONS
XX - REUNIONS ET EXPOSITIONS ANNONCEES

1980. February 12-15 Brussels (Belgium)

50th anniversary Meeting-Commission Intercontinentale du Genie rural: Evolution of Research in Agricultural Engineering
Inf. P. F. Y. ABEELS, Dept. Genie Rural, Univ. Louvain La Neuve Place Croix du Sud, 3, 8-1348 Louvain la Neuve (Belgique)

1980 March 2-6 Charleston (South Calif USA)

XIth annual conference of Environmental design Research association:
Optimizing Environments: Research, Practice and Policy
Inf. Stephanfe SANDERS Center of Metropolitain Affairs. College of Charleston South California 29401 (USA)

1980 April 9-11 Canterbury Kent (UK)

Eucarpia IOBC Meetin. on Breeding for resistance to insects and mites Inf. Miss J.H. Parker, East Malling Research Station Maidstone Kent ME 19 6 BJ (UK)

1980 April 11-13 Atlanta Georgia (USA)

Annual Meeting American Association of Botanical Gardens and Arboreta
inf. Dr. MILDRED E. M. AABGA Dept of Biology Univ. Of California Los Angeles Calif. 90024 (USA)

1980 April to June Wageningen (The Netherlands)

International Agricultural centre (IAC) Course on seed technology in the Netherlands
TFITTUr. J. JONKERS, Wageningen (The Netherlands)

1980 May 5-9 Aarslev (Denmark)

3rd ISHS Symposium on Flower bulbs
Inf. R. E. RASMUSSEN, State Expt. Horticulture Station Kirstinebjergvej 6 Aarslev DK5792 (Denmark)

1980 May 17 september Montreal (Canada)

Floralies internationales de Montreal
Inf. Floralies internationales du Quebec H 2Y 1 P5 (Canada)

1980 May 18-24 Wageningen (The Netherlands)

Fifth International Congress on Soilles Culture (IWOSC)
Inf. pr. A. A. STETNER PO Box 52, 67010 AB, Wageningen (The Netherlands)

1980 May 18-23 Bad Homburg (FRG)

Fifth ISHS Symposium on virus diseases of ornamental plants Inf. Dr. R. TMINGInst. Fur Vtrusserorogie Messeweg 11/12 -33 Baunschweig (BRD)

1980 June 2-4 Forli (Italy)

ISHS Symposium on Vegetable and flower seed production
Inf. Frof. Quagliotti Inst. Of Plant Breeding and seed Production via P. Giuria 15, 10126 Torino (Italy)

1980 June 9-13 Cairns (Australia)

World Wilderness Congress
Inf. The Secretariat PO *Ix 102 Manunda, Cairns 4870 Queensland Australia

1980 June 19-22 Genova (Italy)

International Exhibition and meeting on solar energy
Inf. Fiera di Genova P. Le J. F. Kennedy F6129 Genova (Italy)

1980 June 22-28 Riverside (USA)

Colloque MAB sur la pollution atmospharique
Inf.M.P.R. MrLLER Pacific South west Forest and Range Experiment Station USDA. 4955 Canyon Crest Drive Riverside C. A.92507 (USA)

1980 June 25-27 Gembloux (Belgique)

5ymposium International sur la culture du cerisier
Inf. Station des cultures fruitiares et maralcheres 234 Chaussee de Charleroi 5800 Gembloux (Belgique)

1980 June 29-July 5 Urbino (Italy)

First European Bioenergetics Conference
Inf. Pror. A. Baccarini 4elandr1, Institute Botanic° Via Irnerio 42 40126 Bologna (Italy)

1980 July 6-13 Vancouver (Canada)

ISHS symposium on Breeding and machine harvesting of Rubas
Inf. R. A. DA¯08ENT, Agriculture Canada, Vancouver Research Station 6660 N. W. Marine Drive, Vancouver BC V6T IX2 (Canada)

1980 July 17-24 Vancouver (Canada)

2nd international Congress of Systematic and Evolutionary Biology Inf. Dr. G¯. G. CSCUDDER. Dept of Zoology Univ. Of British Columbia, 2075 Westbrook Mall, Vancouver Brit. Col. Canad. V6T 1W5.

1980 July 20-25 Strasbourg (France)

8th International Congress on Photobiology
Inf. N. CHARLIER Centre de Biophysique Moleculaire 1A av. De la Recherche Scien-tifioue 45045 Orleans Cedex France

1980 July 21-25 Davis Calif. (USA)

2nd Symposium on Post harvest physiology of cut flowers
A. KOFRANEX Dept of Env. Hor¯f.11niv. Oftalifornia Davis, Ca 95616 (USA)

1980 July 22-29 Brisbane (Australia)

V International Symposium on Biological Control of Weeds
Inf. Dr. K,L. S. RARLEY, CSIRO Entomology Private Bag 3 Indooroopilly Queensland 4068 (Australia)

1980 July 27-28 Estes Park Colorado (USA)

Meeting of the Growth Chamber Working group
Inf. P. A. HAMMER Dept of Horticulture Purdue University West Lafayette JN 47906 (USA)

1980 July 27 - August 1 Santiago de Compostela (SPAIN)

II Congress of Federation of European Societies of Plant Physiology Inf. Dr. A. BALLESTER Dept of Plant Physiology Faculty of Biology Santiago de Compostela (Spain)

1980 August 3-8 Merano (Italy)

ISHS symposium on Hight density planting
Inf. Dr. H. OBERDORFEIT, Sud Tirol, Beratungsung f. Obst and Weinbau, Andrea Hoferstr. 9, F 3911 Lana (Italy)

1980 August 3-8 Merano (Italy)

ISHS Symposium Research and development an orchard and plantation systems
Inf. Dr. S. J. WERTREIM Researdh Station for fruit Growing Brugstraat 51, 4475 AN Wilhelminadorg (The Netherlands)

1980 August 3-9 Kyoto (Japan)

XVI International Congress of Entomology
Tnf. Shoziro Ishii, c/o Inter, Conf. Hall Takaraike Sakyo Kyoto 605 (Japan)

1980 August 6 Kyoto (Japan)

Symposium on Genetic and cytogenetics of Vectors
Inf. T. Kanda St Marianna Univilawasalsi 213 (Japan)

1980 August 6-20 STItsai (Greece)

Nato Advances Study Institute. Methods in membrane research and biological energy transduction
Inf. KLIKGENBERG E. M. Dept Physical Bioch. University Goethestr 33. 8 Munich 2

FRG 1980 August 11 Naha Okinawa (Japan)

Symposium on Present Aspects of Fruit Fly Control
Inf. 'Toro Koyama Okinawa Pref:Aijrft Expt Station 4-22, Sikiyamacho Naha Okinawa (Japan)

1980 August 21-5 Davis Calif. (USA)

2nd Int. Symposium on Post harvest physiology of cut flowers
Inf. Prof. A. K. KOFRANEK Dept of 'Environmental Horticulture Univ. Of California Davis CA 95616 (USA)

1980 August 25-30 Debrecen (Hungary)

XI Annual Meeting of ESNA "Waste Irradiation" Inf. Dr. R. ANTOSZEWSKI Research Institute of Pomology 91 100 Skierniewice Poland

1980 August 26-28 Wageningen (The Netherlands)

Eucarpia Meeting on Breeding of Cucumbers and Melons
Inf. X. P. K. den NIJS IVT PO 8 16 Wageningen (Netherlands)

1980 September Brasilia (Brasil)

ISHS Symposium on Vegetable Crop research
Inf. L. Montoya IICA Caixa postal 16 074-IC 01 2000 Rio de Janeiro (Brasil)

1980 September Wageningen (The Netherlands)

ISHS Symposium on Vegetable storage
Inf:Ir. W. S. DUVEXOr, Sprenger Inst. Haagsteeg 6, Wageningen (The Netherlands)

1980 September BRUNSWICK (F. R. Germany)

5th Symposium on virus diseases of ornamental plants
Inf. Ar. Koening, Inst. Virusserologie, Nesseweg 11/T2, 33 Braunschweig BRO (Germany)

1980 September Budapest (Hungary)

11th Symposium on Fruit tree virus diseases
Inf. Dr. H. Ronde, Kristensen, The State Plant Pathology Institute . Ottenborgvej 2, 2800 Lyngby (Denmark)

1980 September Nigeria

VIth Africain Horticultural symposium on indigenous vegetables Inf. Prof. H. D. TINDALL, Nat. Coll. Of Agric. Engin. Silsoe Bedford 4K45 40T (UK)

1980 September Rome (Italy)

International Weed Science Conference
Inf. Or. L.1. BATT1-1EW. Plant Protection Service FAO-Via defile Terme di Caracalla Rome Italy 00100

1980 September 1-11 Nottingham (UK)

Effects of gaseous air pollution in agriculture and horticulture
Inf. Dr. M. H. UNSWORTH. University of Nottingham. School of Agriculture. Sutton Bonington LoughbaUgh Leics LE 12 5RD (UK)

1980 September 1-12 Portugal

Heat pump Fundamentals. Nato Advances Study Institute
Inf. J. BERGHMANNS. Inst. Mechanika, Celestijnenlaau 300A. Heverlee 3030 Belgium

1980 September 2-5 Budapest (Hungary)

Symposium on new Endeavours for Plant Protection
Inf. Z. KFRALY Research rnst. For Plant Protection Box 102 Budapest H 1525 (Hungary)

1980 September 6-14 Tijana (Mexico)

XVII Inst. Con. Ress on Vine and Wine
Inf. M.P. MAURON 11 rue Roquepine 75005 Paris (France)

1980 September 7-12 Dublin (Ireland)

ISHS Symposium More profitable use of energy in protected cultivation
Inf. br. T. O'FLAKERTY Kinsealy Research Centre. Malallide Road. Dublin 5 (Ireland)

1980 September 7-17 Maratea (Italy)

Protein Biosynthesis in Eukaryotes. Nato Advances Study on Institute R. PERETTERCOFF. Tnst. Of Anatomy University Gloliastr. 19, 8006 Zurich Switz

1980 September 8-12 Munich (F. R. Germany)

11th World Conference on Energy
Inf. Organizing committee. Lindemannstrasse 13. D 4000 Dusseldorf 1. F. R. Germany

1980 September 8-12 Niagara Falls (Canada)

Intern. Council for the Study of Viruses and Virus like Diseases of the Grapevine
Inf. R. F. DIAS¯ Vineland¯ Res. Station Ontario LOR 2 EO (Canada)

7980 September 11-14 Orleans (France)

Hortimat. Salon professionnel de materiel horticole
Inf. Hortimat Domaine de Cornay 45590. St Cyr en Val

1980 September 15-19 Wageningen (Netherlands)

ISHS Symposium on postharvest handling of vegetables Inf. W. S. DUVEKOT. Sprenger Inst. Haagsteeg 6, Wageningen (Netherlands)

1980 September 15-19 Bangkok (Thailand)

4e colloque asiatique sur les plantes mddicinales et les apices (UNESCO)
inf. Dr. V. REUTRAKUL Dept. Of Chemistry Faculty of Science
Mahidol University, Rama VI Road, Bangkok 4 (Thailande)

1980 Septembre 16-18 Paris (France)

16e journde de l'hydraulique: Rejets de chaleur à l'atmosphdre Gestion des calories et hydraulique associee.
Inf. Societe Hydrotechnique de France. 199 rue de Grenelle . 75007-Paris (France)

1980 September 16-18 Kiel (FRG)

2nd ISHS Symposium on Fire blight
Inf. Dr. W. ZELLER Biol. Bundesantalt.
Schlosskoppelweg 8 0.2305 Heikendorf Kitzeberg Fed. Rep. Of Germany

1980 September 16-20 Leningrad (USSR)

IX Eucarpia Congress on genetic resources and breeding for resistance
riff. D. D. BREZHNEV. N. I. Vavilov Inst. Of Plant Industry
44 Herzenstr. Leningrad (USSR)

1980 Septembre 23-25 Paris (France)

Cultures sur substrats et irrigation fertilisante (Formation et perfectionnement

Inf. CTIFL Service Formation. 22 rue Bergere 75009-Paris (France)

1980 September 25-28 Karlsruhe (RFA)

Hortec-Salon du materiel horticole professionnel
Inf. KarlsruherKongress. GmbH Festplatz 3 Postfach 1208-7500 Karlsruhe 1 (GFR)

1980 September 30-October 4 Skierniewice (Poland)

Symposium on Drip Irrigation in Horticulture with foreign experts participating
Inf. Prof. K. STowik Research Institute of Pomology and Floriculture 96-100 Skierniewice (Poland)

1980 October 6-11 Lisboa (Portugal)

8th international Agricultural Plastics Congress
Inf. A P P A rue de D. Estefania, 3i, Ze Esq. Lisboa (Portugal)

1980 October 13-December 11 Bet Dagan (Israel)

XII th. International course on irrigation
Inf. Or. K. M. Schallinger The Volcani International Courses PO Box 6. Bet Dagen Israel

1980 October 13-17 Amsterdam (Netherlands)

II Intern. Conf. Of Scientific Editors on Scientific Information Transfer: people, methods and means
Inf. Ms. H. TOMBAL Elsevier Scientific Publ. Co. POB 330 100 AH Amsterdam (Netherlands)

1980 October 14-16 Wageningen (The Netherlands)

Eucarpia Meeting on breeding of Capsicum
Inf. Mr. I. W. MIXEMA I V T PO Box 16 Wageningen (Netherlands)

1980 October 16-17 Atlanta Ga (USA)

Intern. Symposium on Environmental Pollution
Inf. Vijay Mohan Bhatnagar, Alena Enterprises POB 1779 Cornwall Ont. K6H 5VT Canada

1980 Octobre 20-24 Cannes (France)

9e congres de l'Union—internationale d'Elettrothermie
Inf. Comite francais d'Electrothermie. Rue de Miromesnil 75008 Paris (France)

1980 Novembre 4-6 Paris (France)

Mdthodes biologiques appliqudes aux cultures legumieres (Formation et perfectionnement C111-1.)
Inf. CTIFL Service Formation 22, rue Bergere 75009 Paris (France)

1980 December 13-15 Genova (Italy)

Orchid Show and Market
Inf. Fiera di Genova P. Le J. F. Kennedy 16129 Genova (Italy)

1981 International Symposium 'Form and Functions of Plants in Mountains"
Inf. Dr. A. N. PUROHIT. High altitude PlantPF¯ysiology FZesearch Centre. Garhwal University Post Box 14. Srinagar 246174 UP India

1981 Switzerland or Finland
ISHS Symposium on the use of artificial light in horticulture
ISHS Commission for protected cultivation. Box 1011 Aaismeer The Netherlands

1981 or 1982 Aarslev (Denmark)

ISMS Symposium on Production planning in glasshouse floriculture
Inf. Or. V. A. HALLIG, Glasshouse Crops Res. Stat. Kirstinebjergnj 10, OK 5792 Aarslev (Denmark)

1981 Rumania

ISHS Symposium on Apricot culture and decline
Inf. Dr.5. A. PAUNOVIC, Fruit Res. Inst.32000 acak

(Yugoslavia) 1981March 1-10 Wageningen (Netherlands)

III rd International ISMS symposium on Water supply and irrigation in the open and under protected cultivation
Inf. International Agricultural Centre. Postbox 88 5700 AB Wageningen (The Netherlands)

1981 Spring Yugotlavia

ISHS Symposium on Labour and Labourmanagement
Int. Dr. V¯. STMOTTM¯Faculty of Agric. Science Inst. For Economics Simunska 25 41000 Zagreb (Yugoslavia)

1981 April 23-25 Bologna (Italy)

Symposium on Fruit Trees fertility
Int. Secretariat c7¯6 rnstituto Coltivajioni Arboree, Via Celoria 2. 20133 Milano (Italy)

7981 May-San Diego California (USA)

ISMS Symposium on Protected cultivation of carnations
Inf. S. T. BISEPER, 3883 Ashford Street San ¯Diego CA 92111

(USA) 1981May 19-21 Wageningen (The Netherlands)

Symposium on Standardization of Packaging for Horticultural Produce
fnf:SOrenger Institute PO Box 17 6/00 AA Wageningen(The Netherlands)

1981 July 27-31 Aarslev (Denmark)

ISHS Symposium on timing of field production of vegetables
Inf. B. JORGENSEN and J. TENSEN¯, Stateus Forsogstation ¯D¯5792 Aarslev (Denmark)

1981 July 28-30 Oxford (UK)

Meeting on Plant Virus Disease Epidemiology
Inf, Dr. J. K. THRESK Plant Pathology Dept. East Mailing Res. Station Maidstone Kent ME 19 68J (UK)

1981 August 14-19 Sydney (Australia)

XI International Scientific Congress on the cultivation of Edible Fungi
rnf. Secretariat of the Congress. G PO Box 2609 Sydney NSW Australia 2001

1981 August 16-23 Cali (Colombia)

V Intern. Conf. on Plant Pathogenic Bacteria
Inf. C. LOZANO CIAT. Apartado Aero 67-13 Cali (Colombia)

1981 August 21-28 Sydney (Australia)

XIII International Botanical Congress
Inf. Or. W. J. CRAM Secretary University of Sydney NSW 2006

Australia 1981August 25-28 Bari (Italy)

III Intern. Symposium on Verticilium
Inf. Dr. M. CIRULLI Inst. Di Patoiogia Vegetale Via G. Amendola 165/A Bari 70126 (Italy)

1981 Rout Versailles (France)

ISHS Symposium on Protected cultivation of chrysanthemum (propagation, fTower physlology, nutrition)
Inf. Prof. P. Lemattre, Ecole Nat. Sup. Horticulture, 4 rue Hardy 78000 Versailles (France)

1981 August-September Hamburg (G. F. R.)

Eucarpia Meeting on Rose Breeding
rnf. L. U. SPARNAAY IVT POB 16 Wageningen (The Netherlands)

1981 September Wageningen (The Netherlands)

Eucarpia Meeting on mutation and polyploidy
Inf. C. BROERTJES ITAL POB 48 Wageningen (The Netherlands)

1981 September 15-21 Durban (South Africa)

10th World Orchid Conference
Inf. Organizing committee PO Box 10630, Marine Palace Durban 4056 South Africa

1981 September 27 - October 1 Aberdeen (UK)

XII Annual Meeting of ESNA
rnf. Dr. R. ANTUSZEWSKI Research Institute of Pomology 96-100 Skierniewice Poland

1981 October Poland

Symposium on Nutrition and fertilization
Inf. Prof. O. NOWOSIELUI Veg. Res. Inst. G6-100 Skierniewice Poland

1981 November 9-13 Japan Tokyo

International Citrus Congress (ISC)
Inf. international Citrus Congress. Okitsu Branch Fruit Tree Research Station
Shimizu 424 02 Shizuoka (Japan)

1982 February 8-16 New Delhi (India) Intern. Congress on
Soil Science Inf. Dr:M. B. BUUCHE Station de recherches
sur la Faune du Sol.
7 rue de Sully 21034 Dijon Cedex (France)

1982 July Tokyo (Japan)
V Intern. Congress of Pesticide Chemistry

Inf. Tomomasa Misato Inst. Phys. And CHem. Research

2-1 Hirosawa Wakashi Saitama 351 (Japan)

1982 August Aarslev (Denmark)

Production planning of Glasshouse floriculture (ISHS)
n ' '. Ha ig 'esearc nstitute or ass ouse Crops Kirstinebjergvej
10 DK 5792 Aarslev Denmark

1982 August 9-13 Boulder Colorado (USA)
IX Congress of the International Union for the Study of Social Insects

Or. M. D. BREED University of Coioraao Boulder (USA)

1982 August 22-27 Conventry (UK)

The 9th International Colloquium on plant Nutrition (formely Plant Analysis)
Inf. Dr. B. J. Greenwood, National Vegetable Research Station Wel lesbourne
Warwick C V 35 9 EF (UK)

1982 6 months Floriades des Pays Bas

1982 August 29 - September 4 Hamburg (FRG)

XXI st International Horticultural Congress
Inf. The Secretariat Hamburg Congress Centre POB 302360 D 2000 Hambourg 36 F. R. Germany

1983 Wageningen (The Netherlands)

X Eucarpia Congress
Ihf.'H. Lamberts Foundation for Agricultural Plant Breeding
POB 11; Wageningen (The Netherlands)

Nous remercions a l'avance, toes ceux qui nous enverront des informations ou articles que nous reproduirons, si possible, dans les prochains numeros.

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

R. Jacques and N. De Bilderling