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PHYTOTRONIC NEWSLETTER N° 10

Contents

I - EDITORIAL

Here is our 10th bulletin, continuing to bring you scientific and technical news. With the encouragement we have been received, it seems to have been a successful venture.

Some of our readers have asked us to change our "low budget" presentation (a Newsletter edited in offset by our laboratory with the generous assistance of the Gif-Orsay Division of the CNRS) into a "journal" distributed on a subscription basis.

In our opinion this change would not be opportune at this time due to the financial difficulties science is facing in the world and the economic crisis in general. In addition, proceeding to such a stage would require facilities for bookkeeping, a subscription department, and above all, the creation of an Editorial Committee. All of this would fatally limit our objectives, our freedom, our possibility to inform the largest possible number of readers by remaining a general link for all those, far or near, who take an interest in phytotronics. our present freedom to maneuver allows us to publish all papers that are sent to us and which might interest at least some of our readers, without any limitation. This is a liberty which the Gif Phytotron desires to conserve for as long a time as possible.

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

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

Thank you in advance.

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

We believe that it contains news which should interest a fairly wide range of disciplines.

In the chapter on Symposia and Meetings : Dr M. Mousseau analyzes the Symposium in Diepenbeck-Hasselt in August 1974 : Environmental and Biological Control of Photosynthesis, with summaries of papers from the literature which was distributed.

Dr Y. Boyer gives us an account of a working meeting of a group which studied Roots in October 1974. This meeting, while fairly technical, may still be of some interest to those not directly concer-ned by these problems. Finally, for the 3rd meeting in Dubrovnik we have published only the titles, of the lectures given on the International Seminar on Heat and mass Transfer in a Vegetative Environment.

Under the heading Research Strategy, two papers are mentioned. The firs, by Dr CHM van Bavel and Dr K.J. Mc Cree on the Design and Uses of Phytotrons in crop productivity study is a lecture presented at the Duke University Symposium in May 1972 but which is still of as great value today as it was then. The second is that of Professor P.J. Kramer on a National Science Foundation Project with, as its first application : uniform sprinkling of potted plants.

For Technique and Practice, we have a paper distributed at the International Horticultural Congress in Warsaw in September 1974 by Dr Z. Guminska on Hydroponic Culture in Wroclaw which lays out some interesting practical suggestions. A paper sent by Dr D.T. Patterson and Dr J.L. Hite describes an Automatic CO2 Control System for growth chambers and greenhouses and is, obviously, of great interest.

Finally, as always, a series of News for Phytotronists ends this anniversary issue since this is our 10th Newsletter.

Our editorial concludes with a request that our readers keep us informed of all meetings and send us new reports able to interest our readers.

Thank you in advance.

P. CHOUARD and N, de BILDERLING

II - ENVIRONMENTAL AND BIOLOGICAL CONTROL OF PHOTOSYNTHESIS

Diepenbeck-Hasselt (Belgium) 25-31 August 1974

Dr M. Mousseau (France) gives our readers the following general description of this meeting

A Symposium intitled "Environmental and Biological Control of Photosynthesis" was held in Belgium between the 26th-30th September 1974. It was organized by Dr R. Marcelle of the research Station of Gorsem, together with the new opening Limburg's University, 40 participants were invited from all over the world.

Papers were given in the morning and informal free open discussions took place every afternoon between all the participants. The proceedings of this Symposium will be published in a JUNK Edition during the first months of 1975.

One of the aims of the meeting was to confront people interested in photosynthesis with two different view points : the "environmentalists" and the specialist of biochemical and cellular level. This was achieved by special sessions on the action of external factors (t^{o}, light, CO_2) on photosynthesis, as well as the action of internal factors such as aging, hormones, chemicals or stress effects on photosynthesis. One session was devoted to the flowering problem in connection with photosynthesis and another one on CAM plants (Crassulacean acid metabolism).

Among the problems discussed were the Following :

- the light and temperature adaptation of photosynthesis
- the measurement and the role of photorespiration
- the action of endogenous factors on photosynthesis
- the regulation of photosynthesis and respiration
- the adaptative aspects of functionning of CAM plants etc...

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From the papers distributed to participants during this meeting we chose the following summaries for our readers classified according to program schedule.

J.L. PRIOUL and P. CHARTIER (France) - Carbon dioxide Transfer resistances : what can be said about their existence and their significance - Description of biophysical models for photosynthetic gas exchanges which lead to the definition of 4 resistances to CO_2 transfer : air-leaf boundary layer (Za)7 water saturation in sub-stomatal cavities at leaf temperature (Zs) transport component of intracellular resistance (Zm) and carboxylation component of intra-cellula resistance (Zx). The structural and metabolic basis for 2m and 2x are analysed using Lolium multiflorum as material.

G. CORNIC (France) - Gaseous exchanges in Sinapis alba cultivated at two different temperatures : 12°C and 27°C - Utilizing assimilation leaf model of Chartier analyses have been done on resistance to CO_2 diffusion from atmosphere to photosynthetic sites. Study of variations in mesophyle resistances depending on temperatures and O_2 atmospheric concentration.

K.J. TREHARNE and C.J. NELSON (U.K.) - Effect of growth temperature on photosynthetic and photorespiratory activity in temperate graminae Plants from 8 populations of Festuca arundinacea (tall fescue) were grown in controlled environments at 10°, 15°, 20° and 25° C with a 16h day and at 8° in a 8 h day. Gas exchange measurements and enzyme activity determinations were made on single leaves at defined growth stages, along with studies of leaf morphology and anatomy.

W.J.S. DOWNTON and J.S. HAWKER(Australia) - Response of starch synthesis to temperature in chilling-sensitive plants. The effect of temperature over the range 3° to 33° on both soluble and granule bound starch synthetases in a variety of chilling sensitive plants are examined and compared with the same effect on a chilling resistant plants. Results indicate a significant temperature effect in chilling-sensitive plants due to a lipid interaction within the growing starch grain.

G. HOFSTRA (Canada) - The effects of temperature and CO_2 enrichment on photosynthesis in soybeans. In a phytotron the growth of soybean plants can be enhanced by CO_2 enrichment around optimum temperatures for growth. Accumulation of starch in the leaves at sub-optimal temperatures or under a CO_2 enriched atmosphere suppresses the rate of CO_2 assimilation. Changes in mesophyll and stomatal resistance will be related to starch and sugar levels. Leaf morphology was also affected by the temperature and CO_2 treatments.

M. MOUSSEAU (France) - The effects of daylength on daily CO_2 balances Daily CO_2 exchanges have been followed on *Sinapis alba* L., grown in short or long day conditions. 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 balance, especially on the short day grown plant. In all daylenghts there is a significant correlation between CO_2 gain in the light and loss in the dark, but this dependence may be different in short and long day plants.

J. POSKUTA and A. FRANKIEWICZ-JOZKO (Poland) - Enhanced dark CO_2 fixation by maize leaves in relation to previous illumination and oxygen concentration. Enhanced dark CO_2 fixation can be observed at light compensation point and it was practically saturated by relative low light intensity. At the light compensation concentration the enhanced dark CO_2 fixation was equal to the about 30 seconds rate of dark respiration and was not affected by CO_2 concentration. Results are tentatively explained in terms of an activation by light and CO_2 of the carboxylation enzyme and (or) the biosynthesis of assimilatcm* power during pre-illumination and its utilization in the process of enhanced dark CO_2 fixation.

L.J. LUEWIG (U.K.) - Tomato leaf photosynthesis and respiration in various light and CO_2 environments. Different ambient CO_2 concentrations determine change in the rate of photorespiration, resulting from a marked change in photosynthetic and intermediary metabolism and this was subsequently reflected in the rate of leaf respiration at night. It is suggested that the environment during photosynthesis controls not only the amount of carbon assimilated, but also the nature of the products of photosynthesis and the efficiency of their utilization.

W.L. OGREN, W.A. LAING and R.H. HAGEMAN (USA) - Regulation of soybean photosynthesis and photorespiration by Ribulose-1,5-Diphosphate carboxylase. Temperature influences the Kinetic properties of purified soybean Rigulose-1,5-diphosphate carboxylase and photosynthesis in soybean leaves. A model, based on the Kinetic properties of Rigulose-1,5-diphosphate carboxylase, accurately describes the effect of O_2 on photosynthesis and photorespiration in the linear portion of the CO_2 response curve.

J_ TROUGHTON and D.C. FORK (USA) - Environmental regulation of photosystems I and II, as monitored by cytochrome F activity in vivo in ulva. Pronounced light adaptation phenomena were observed which can be interpreted as influencing the quantum efficiency of the photosystems. The response of each photosystem to light adaptation was different, and suggests reorganisation or redistribution of light energy within the chloroplast, presumably for more efficient utilisation of light.

H. GRAHL (B.R.D.) - Light induced changes in the photosynthetic apparatus in Sinapis alba. The plants, which are cultivated under strong light conditions show a high concentration of several redox systems, which are assumed to function in the photosynthetic electron transport. Plants grown in weak light show a much more lower concentration of the same systems. This could be found for several Iipophilic plastid-quinones, ferredoxin and cytochromes. As a contrast the chloroplasts of both types of plants show the same concentration of p700. The high rate of CO_2-uptake in light plants is correlated with an increase of photosynthetic prime-reactions.

A. WILD, W. RUHLE and H. GRAHL (B.R.D.) - The effect of light intensity during growth of Sinapis alba on the electron transport and the photophosphorylation. A study of the effect of light intensity during growth on the contents of soluble protein and manganese, the capacity of photosynthetic electron transport and the noncyclic and cyclic photophosphorylation.

D.A. CHARLES-EDWARDS (U.K.) - The basis of expression of leaf photosynthetic activity. Analysis of the response of leaf structure and photosynthetic activity in L. perenne and L. multiflorum to contrasting growth light and temperature environments. Photosynthetic rates have been calculated on the basis of leaf area, of leaf volume and of leaf mesophyll tissue volume. Discussion of leaf photosynthetic data in relation to the physiological and mathematical interpretation of information on the response to the plant growth environment.

M.M. LUDLOW (Australia) - Water stress defers leaf senescence. When leaf net photosynthesis of green panic reaches zero during a drying cycle (at a leaf water potential of about -12 bars) the normal decline of photosynthesis, associated with leaf ageing ceases until the plant is rewatered and active net photosynthesis recommences. This suspension of photosynthetic decline occurs at stress levels down to -90 bars as long as leaves do not die as a direct result of water stress (as opposed to death associated with senescence). The photosynthetic mechanism was not permanently affected by these levels of stress, and surviving leaves attained rates after rewatering greater than those of the same chronological age but comparable with control leaves of the same physiological age.

SPECIAL SESSION ON FLOWERING

C.L. HEDLEY (U.K.) - The involvement of CO2-uptake in the flowering behaviour of 2 varieties of Antirrhinum majus. Two extreme Antirrhinum varieties were chosen : an early flowering forcing variety and a late flowering summer variety. The late flowering variety exhibited a marked interaction between daylength and light intensity, showing no response to photoperiod when grown at relatively low light. The data is interpreted in terms of a dual requirement for floral induction; a primary photoperiodic stimulus and a secondary modifying system associated with assimilation rate. Possible variations in this secondary system will be presented on factors which contribute to net assimilation rate.

R. KANDELER, B. HUGEL and Th. ROTENGURG (Austria) - Relations between Photosynthesis, acid metabolism and flowering in Lemnaceae. In Lemnaceae photosynthesis acts on flowering by production of sugars, ATP and, possibly, reducing energy. However, working with explanted flower primordia we come to the conclusion, that the effects of sugars and nucleotides are indirect, acting rather on flower induction processes in the leaf than on the shoot meristem itself. A connection seems to exist also between acid metabolism and flowering. Certain factors (phytohormones, acetylcholine, sugar) have a "short-day effect" in long day not only on flowering, but also on acid production. Possibly, both processes are regulated photoperiodicaly through mediation of phytohormones.

J. POSKUTA, E. PARYS, E. OSTROWSKA and E. WOLKOWA (Poland) - Photosynthesis, photorespiration, respiration and growth of pea see_____ treated with GA3. The plants which seeds soaked for 24 hours in the solution of GA3 in concentration 10 or 100 ppm showed a considerable increase of the photosynthesis, photorespiration, respiration of shoots, the respiration of roots and seeds, the growth of plants in water cultures and on sand or soil. The growth of such seedlings was greatly stimulated by GA3, particulary after treatment of seeds with 100 ppm GA3 and resulted in 2-3 fold increase in the accumulation of biomass and plant yield.

G. OBEN and R. MARCELLE (Belgium) - Effects of CCC and GA3 on photosynthesis in primary leaves of Phaseolus vulgaris. Report on the results obtained by measuring some key enzymes of the amino acid biosynthesis (GDH, GOT and MDT). These activities were found to parallel the modifications of protein and chlorophyll content, induced by both growth regulators. In isolated chloroplasts the activities of both photosystems were investigated as well as cyclic photophosphorylation. No significant differences could be found between treated and untreated leaves. It is suggested in the discussion that the effects of CCC and GA on APS might be searched in the relation between chloroplasts and the rest of the cell as well as at the level of photosynthate transport.

J.M. MICHEL (Belgium) - Effects of CCC on photosynthesis in Euglena. Study on light grown *cells* of Euglena graiciis and the effect of CCC on the photosynthetic apparatus. CCC inhibits the rate of cell division. The biosynthesis of Chlorophylls is also affected, the cell content in total chlorophylls is depressed as well as the synthesis of Chi_ a relative to that of Chi. b. Measurements of light minus dark oxygen exchanges at several intensities by whole cells show an inhibition of the oxygen evolved by the CCC treated cells. Some photochemical reactions of Chloroplasts show that, chloroplasts extracted from Euglena grown in the presence of CCC have a higher Hill-activity but a lower P 700 content than control.

P.E. KRIEDEMANN (Australia) - Environmental and biological regulation of photosynthesis in higher plants. Both environmental and internal effects on photosynthesis have been analysed in terms of hormonal physiology. Photosynthetic changes were resolved into stomatal and residual components following concurrent measurements of assimilation and transpiration (02-free gas stream) under laboratory conditions. Both woody perennials and herbaceous annuals provided test material. Environmental factors such as moisture stress, or alterations of photoperiod, which led to a decrease in rates of gas exchange, were correlated with increased levels of endogenous abscisic acid (ABA) and phaseic acid (PA). Conversely, treatments which led to increased rates of gas exchange were associated with lower levels of ABA and PA. These environmental effects were heightened by the presence of fruits but these increases were not a consequence of decreased leaf water potential . Fruits and other developing organs do represent sinks for assimilates, but are also sources of growth regulators which might influence CO2 fixation directly, or at least cause some displacement in hormonal levels within adjacent leaves. Photosynthetic responses to such internal regulation would then seem attributable to the combined effects of assimilate demand and hormonal stimulation. While the chemical nature of this "sink factor" is at present being resolved, it is proposed that changes in endogenous *levels* of ABA and possibly PA, do represent a part-mechanism for regulating gas exchange by mature leaves.

J.O. HESKETH, *J.W.* JONES, D.N. BAKER and J.M. Mc KINION (USA) - Problems in building computer models for photosynthesis and respiration. Currently, objectives in modeling center around simulating the supply of photo-energy available for metabolism of Carbon, Nitrogen and Sulphur. Some of this energy supply cannot be monitored by standard gas exchange methods. Studies involving careful budgets of C, N and S metabolism as well as ATP and NAD(P)H2 synthesis in the light and dark are important. Such studies need to be done first under defined conditions and then must be extended to different environmental and biological conditions. Several biological processes are differentially sensitive to water-stress, among other things. Diurnal changes may occur in relevant processes, requiring careful budgets at different times of day. A plant growth model requires a budget of incoming energy, respiratory needs for maintenance and growth processes, and nutritional requirements for organogenesis. There are several approaches to modeling incoming energy involving gas exchange. If leaf or chloroplast models are to be used, then more work must be done relating the display of photosynthetic units in a plant stand to interception of light. Estimates involving exchange theory must be coupled with careful measurements of respiration in the system. Dry matter sampling must be coupled with factors for conversion of C, N and S into dry matter, as well as associated energy requirements. We must continue to focus on the efficiency of dark respiration in generating energy for metabolism.

P. HOFFMANN and Z. SCHWARZ (D.D.R.) - Characterization of regulative interactions between the autotrophic and the heterotrophic system in phaseolus and triticum-seedlin s. The system of NAD- and NADP-dependent GAPDH is suitable or the characterization of the regulative interactions between the systems controlling energy metabolism. In the course of development the activity of the respiratory NAD GAPDH decreases in the same extent as the photosynthetic NADP-GAPDH increases. The enzymatic compensation point resulting from this behavior is reached shortly before the gas-exchange compensation point. Retardation of the development of the photosynthetic apparatus by NaC1$^-$, chloramphenicol$^-$ or CCC-application retards correspondable the recruiting of the compensation points and the entrance in the autrophic phase. The effect on the adenylate-level is discussed. Further examinations indicate the primacy of energy formation for differentiation and maintenance of structural compartments integrity of which guarantees the complete function of the photosynthetic apparatus.

D.I. DICKMANN (USA) - Correlation of certain biochemical and physiological parameters with photosynthesis during leaf development in Populus. Dark respiration, apparent photorespiration and CO_2 compensation concentrations decrease as Leaves mature and age, but then increase with the onset of senescence. Photosynthetic rate reaches a maximum just before leaves reach full expansion, then subsequently declines. Leaf diffusion resistances vary inversely with photosynthetic rate throughout leaf development. During leaf expansion protein synthesis and ribulose diphosphate (RuDP) carboxylase activity are closely correlated with photosynthetic rate. Chlorophyll concentrations increase throughout leaf development and are not well correlated with photosynthesis. Synthesis of Fraction I protein (RuDP carboxylase) occurs only during leaf expansion and, as opposed to other proteins, does not turn over. Thus, as the leaf ages a gradual decrease in RuDP carboxylase activity Occurs which, when combined with higher leaf diffusion resistances, accounts for the decline in photosynthetic rate.

P.H. HOMANN and M.L. SALIN (USA) - Photosynthesis and photorespiration in developing leaves. The rate of photosynthetic CO_2 fixation in young and old tobacco and citrus leaves was found to be quite insensitive to changes in the external oxygen tension. In mature leave§ however, the CO_2 uptake in the light was inhibited at elevated oxygen tensions. These observations can only partially be explained by an increase of the activities of photorespiratory enzymes as the leaves become older. Various types of experiments have indicated that the apparent increase in photorespiration during leaf development is largely due to changes in the leaf resistances to gas diffusion.

N.O. ADEDIPE (Nigeria) - Aspects of translocation profiles in Hibiscus esculentus (OKRA). There are differences in Translocation magnitudes and patterns in leaves of different age. It showed that the influence of nitrogen is different from, and generally opposite to, that of P, and that the general lack of P effect could be attributed to a lack of growth response, indicating a very low P requirement for okra plant growth. The study also showed that soil water regimes would have to be very low to have any significant influence on translocation in the okra plant, an indication of a high degree of drought-tolerance.

J.H. TROUGHTON (New-Zealand) - Light and the speed of carbon transport in C3 and C4 plants. The influence of light and dark, and light level on the speed of translocation has been investigated in maize, rice, wheat and tomato using in vivo measurement techniques with the isotope carbon-11. On transfer of a plant from light to dark, the speed of translocation was reduced reached a new equilibrium value, about 25 % of the speed in 25 Wm (400 - 700 nm). On transfer from dark to Light the speed increased within 3 hours to a speed approximately proportional to the light level. Shading portions of the leaves established that the speed was not determined by a particular site, but that the speed in a leaf was dependent on the total activity upstream from the segment over which the speed was measured. A speed of translocation estimated at several stages of growth was shown to be relatively constant.

SPECIAL SESSION ON CAM

J.W. BRADBEER, W. COCKBURN and S.L. RANSON (U.K.) - The labellinq of the carboxyl atoms of malate. When acidifying leaves of Crassulacean plants fix $^{14}CO_2$ in the dark, two-thirds of the radioactivity incorporated into malate is normally found in carbon atom 4 with the remaining one-third in carbon atom 1. Consideration will he given both to the possible ways in which this distribution of label in malate may arise and to a possible explanation for the malate labelling reported by Sutton and Osmond in 1972.

W. COCKBURN (U.K.) - The pathway of malate synthesis in crassulacean acid metabolism. Description of the method of using the stable isotope C^{13} and mass spectrometry in experiments designed to quantify the extent to which double carboxylatim contributes to the synthesis of malic acid in the dark from carbon dioxide by leaves of Bryophyllum Daigremontianum.

M. KLUGE (B.R.D.) Malate synthesis in Crassulacean acid metabolism via a double CO_2 dark fixation. The results presented provide some evidence that a double CO_2 fixation might not operate in vivo in the ;relate synthesis during CAM. $^{14}CO_2$ dark fixation and synthesis of ^{14}C-malate in leaf tissue slices obtained from the CAM plants Kalanchoe daigremontiana and Sedum praealtum were clearly stimulated by exogenously applied unlabeled PEP or 5-PGA. However, no alteration in the label ratio between the carboxyls of malate $-^{14}C$ could be observed under these conditions. This suggests that malate molecules deriving from the exogenous CO_2 acceptors show the same label distribution as malate deriving from endogenous PEP (i.e. about 1:2 between Cl and C4), although they were definitely not the product of a double CO_2 fixation. So the assymetrical label distribution in malate $^{14}CO_2$ produced in CAM cannot be regarded as evidence for a two step mechanism in CO_2 dark fixation. However PEP prelabeled by RuDP carboxylase catalysed $^{14}CO_2$ fixation is used in malate synthesis in the light. This is indicated by the increase of label in Cl - C3 of malate with increasing light intensity during CO_2 fixation. In presence of DCMU, however, the label distribution in malate remained the same as in the dark.

I.P. TING, S. SZAREK and H. JOHNSON (USA) - Photosynthetic efficiency of CAM plants in relation to C and C_4 plants. Crassulacean acid metabolism (CAM) is the massive (100-200 *meg/g)* diurnal fluctuation of organic acids, e.g., malate resulting from a dark or night-time carboxylation via P-enolpyruvate carboxylase, followed by a subsequent decarboxylation during the following light period, and concomitant photosynthetic CO_2 fixation via Ribulose diphosphate carboxylase. When in the CAM mode, the carbon assimilation pathway is not too unlike C4 photosynthesis except for the two sequential carboxylation reactions being separated in time (CAM plants) rather than space (C4 plants). The CAM mode similarly to C4 photosynthesis apparently results in transpiration ratios (i.e., water lost to carbon assimilated) much lower than in C3 plants. Average transpiration ratios (IR) for CAM, C_4, and C_3 plants are on the order of 150, 300, and 600 respectively.

T.F. NEALES (Australia) - The as exchange patterns of CAM_plants. The gas exchange patterns o CAM plants, from various families, are qualitatively different from those of C3 and C4 plants. Portulacaria afra appears to be an intermediate form. Halophyte succulents, such as Disphyma australe, have non--CAM gas exchange patterns. Evidence will be presented indicating that, within the Orchidaceae, there may be CAM and non-CAM forms. The extent to which, in our experience, the CAM pattern of gas exchange may be affected by drought, night temperature and salinity will also be described.

C.B. OSMOND (Australia) - Environmental control of photosynthetic options in Crassulacean plants. Photosynthetic metabolism in plants capab e of Crassulacean acid metabolism (CAM) may involve the net fixation of CO2 in the preceeding dark period or the net fixation of 002 in the light. The biochemical properties of these two photosynthetic options have been examined and evidence will be presented which suggests that dark fixation is essentially a C4- like process and light fixation is essentially a C3-like photosynthetic process. A number of environmental conditions directly influence the contribution of 03-like and C4-like photosynthetic options to the net carbon gain of these plants. These responses, and the relationship to growth and persistence of these species will be discussed.

J.C. LERMAN (France) - Isotope composition of plants : variations due to environmental changes. A proposal model explains the large variations observed in the carbon isotope composition of CAM plants. This model may provide information about (1) the proportion of carbon fixed by each one of the two primary carboxylations, as indicated by isotope analysis of the soluble fraction, and (2) the size of the intermediate pool of organic acids from where the second decarboxylation draws its carbon, as deduced from the difference between the isotope composition of the soluble and the insoluble matter. The model contains as particular cases the C_3 and C4 plants. Results obtained by different authors are compared and discussed on basis of this model, trying to assess how much of the observed variations in the C 13/C 12 ratio of the three types of plants can be due to three following causes :

1) variation of environmental parameters as the composition of the atmosphere,
2) variation of reaction rates due e.g. to variations of the temperature, and
3) variation of the type of carbon fixation correlated with environmental parameters (e.g. temperature, illumination) and biologic characteristics (e.g. age, growth rate).

B,G. SUTTON (USA) - Control of glycolysis in succulent plants at night. Environmental factors which limit malic acid accumulation at night do so by limiting production rather than by stimulating consumption. The enzymes of glycolysis were isolated from leaves of succulent plants and the activities measured were sufficient to accommodated measured rates of acid accumulation, Phosphofructokinase from the succulent plant was shown to be 100-fold less sensitive to inhibition by PEP than the same enzyme from a non-succulent plant. Together with other known regulatory systems in succulent plants, this feature of phosphofructokinase seems particularly important in allowing continued synthesis of carboxylation substrate and the accumulation of high concentrations of malic acid, The properties of the other important regulatory enzyme of glycolysis in succulent leaves, phosphorylase, were consistent with the path of carbon flow outlined above.

R. MARCELLE (Belgium) - Effect of photoperiod on the CO2 and 02 exchanges in leaves of Bryophyllum Daigremontianum (Berger). A study of this exchange in attached leaves. The photosynthetic activity measured by oxygen emission depended only on either the atmospheric CO_2 or on the endogenous CO2 pool supplied by the decarboxylation of stored malate. In LD but not in SD, the light dependent decarboxytation of malate presented a lag phase; in both daylengths, an other lag phase seemed to occur between the beginning of decarboxylation and the onset of the oxygen emission.

O. QUEIROZ (France) - Rhythmical characteristics in CAM regulation. No summary.

I. ZELITCH (USA) - General assessment. No summary.

III - MEETING ON "ROOTS", NANCY (FRANCE)

October 24-25, 1974.

This meeting took place at the Centre National de Recherches Forestieres (CNRF) of Champenoux (near Nancy). It was organized by Mr RIEDACKER (Laboratoire de Sylviculture et Production du CNRF).

39 participants came together; France, Belgium, Great Britain, Canada were represented.

The scientific preoccupations of each participant covers a wide range of research subjects (morphogenesis, mineral nutrition, study of correlations, physiology of nodosities, pathology, root competitions, etc..) but with one common denominator : the necessity to accede to the root system of plants. This meeting therefore aroused great interest, given the number of problems that remain unsolved to allow for this accessibility, notably as concerns big plants, whether perennials or not. Therefore, the meeting provided mainly a confrontation (in an informal way) of methodologies : perfecting rhizotrons, controlling ambient conditions : temperature, oxygenation, mechanical pressure, nutrition... (with several reports of results relative to the effects of these factors on plant behavior).

According to the conditions of culture, it is possible to classify the different methodologies under two different headings : controlled conditions and natural conditions.

Culture in controlled conditions

A large choice of devices, the main problems to solve being control of environmental conditions, as well as an incomplete knowledge of the optimal natural conditions for growth which must be reproduced :

3 types of growth cabinets were tested and perfected :

nutritive mist (Clermont-Ferrand)

- Hydroponic culture (Gif-sur-Yvette, Grenoble, Cadarache and Versailles).
  Particular example of culture of Aulne plantlets for microscopic examination (University of Nancy).

If no method exists which copies nature, several devices should be considered essentially as a function of the aim desired. Improvements will have to do with interface problems for creating a rugosity, a rigidity (porous-baked clay environment) and on the oxygenation of the medium.

- solid medium : (soil or inert support)
  flat boxes with moveable covers (Einviile)
  inclined tank (Clermont-Ferrand)
  neutronography (Cadarache).

Culture in natural conditions :

- trenches making possible the numbering and measuring of roots : perfecting the lay-out of the trench : logarithmic spiral (Pont de la Haye),

- radioisotopic techniques (Grenoble), non-destructive technique (injection of radioactive Rubidium in tree trunks, detection of radioactivity by -ray detectors spaced regularly around the tree, complementary information by samples of self-radiographed roots).

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Editors' Note : This short report which will interest certain readers was written by Dr Y. Boyer (INRA - Route de Saint-Cyr, mow Versailles, France). We would be interested in receiving other technical reports or notes of a similar nature which bring together technicians and researchers for informal discussions. News of this kind can either stimulate new ideas, be the origin of scientific or technical contacts or else even serve as a beginningfbr meetings, lectures or exchanges of views on important questions and on an international level. We await these reports for publication and in advance thank those who send them to us.

IV - VIIth INTERNATIONAL, SEMINAR OF HEAT AND MASS TRANSFER IN THE ENVIRONMENT OF VEGETATION

Dubrovnik (Jugoslavia), August 26-30 1974

This seminar was organized and support for the organization granted by Unesco - Jugoslav Federal Council for Scientific Coordination - Academy of Sciences of USSR and University of Technology-Eindhoven -

The Netherlands. It was followed by the Fifth International Heat Transfer Conference at Tokyo (Japan) on September 3-7, 1974.

In this seminar there are several sections and below we have reproduced only the titles of all papers presented. For more informations please contact Prof. D.A. de Vries - Department of Physics University of Technology - Postbus 513 - Eindhoven - The Netherlands.

SECTION I - SOIL : 3 lectures and 8 papers

Lectures 1 - D.A. de VRIES - Heat transfer in soils.

2 - J.R. PHILIP - Water movement in soil.

3 - S.V. NERPIN - Thermodynamic and rheological pecularities of soil water and their role in energy and mass transfer

Papers

1 - R.D. JACKSON, B.A. KIMBALL, R.J. REGINATO, S.B. IDSO and *F.S.* NAKAYAMA - Heat and water transfer in a natural soil environment.

2 - D.E. SMILES and P.M. COLOMBERA - The early stages of infiltration into a swellong soil.

3 - G.C. VANSTEENKISTE and F. de SCHUTTER - Comments on computer modeling of a moisted soil.

4 - D. SLEGEL, L. DAVIS and L. BOERSMA - Simultaneous heat and mass transfer in soils with subsurface heated porous pipes.

5 - N.V. CHURAEV- Surface phenomena convected with evaporating mater and condensing water vapour in thin capillaries.

6 - A. ROSEMA - Simulation of the thermal behaviour of bare soils for remote sensing purposes.

7 - B. CERMAK and J. VALCHAR - A contribution to the conception of thermodynamic potential of humidity in colloidal capillary-porous materials.

J.MITCHELL, W. BECKMAN, R. BAILEY and W. PORTER - Microclimatic modeling of the desert.

SECTION II - LOWER ATMOSPHERE : 5 lectures and 12 papers

Lectures :

1 - J.A. BUSINGER - Aerodynamics of vegetated surfaces

2 - B. LEGG and *J.* MONTEITH - Heat and mass transfer within plant canopies

3 - J.M. NORMAN - Radiative transfer in vegetation

4 - F. KREITH and W.D. SELLERS - General principles of natural evaporation.

5 - *A.* PERRIER - Methods of observation of heat and mass transfer in the lower atmosphere and in plant canopies.

Papers :

1 - W.Z. SADEH - Simulation of flow above forest canopies

2 - P.H. SCHUEPP and K.D. WHITE - Energy and mass transfer in vegetation by electrochemical analog

3 - J. ROSS and T. NILSON - Radiation exchange in plant canopies.

4 - J.D. BERGEN - An approximate analysis of the momentum balance for the airflow in a pine stand.

5 - J. A. CLARK and G. WIGLEY - Heat and mass transfer from real and model leaves.

6 - G. DEN-HARTOG and R.H. SHAW - A field study of atmospheric exchange processes within a vegetative canopy.

7 - D. ROSENZWEIG - Canopy flow in a row-crop under a pressure gradient.

8 - M. ELDIN, G. GOSSE, B. MONTENY and D. CARDON - energy and water exchanges of a grass canopy in a humid tropical climate.

9 - B. SEGUIN - Estimation of potential evapotranspiration in Mediterranean regions : adaptation of Penmans Method to tropical climatic conditions.

10- A. BAILLE and J.P. CHIAPALE - An eddy correlation method for the determination of momentum, heat and *mass* transfer.; using hot-wire anemometry.

11- F. DURST, G. WIGLEY and M. ZARE - Laser -doppier anemometry and its application for flow investigations in the environment of vegetation.

12- C.L. PALLAND - Measurement of atmospheric infrared radiant flux and testing of some empirical formula for estimating this flux.

SECTION III - PLANTS 1 lecture and 3 papers

Lecture : P.G. JARVIS - Heat and Mass transfer in plants.

Papers :

1 - O.T. DENMEAD and B.D. MILLAR - Water transport in wheat

2 - I. IMPENS and R. LRMEUR - Bondary layer, stomata]. and CO2 transfer resistances from leaves within a sunflower.

3 - C.J. STIGTER - Water vapour diffusion porometry for leaf epidermal resistance measurements in the field.

SECTION IV BIO-ENGINEERING OF PLANT GROWTH AND PRODUCTIVITY

2 lectures and 9 papers.

Lectures :

1. -A.A.NICHIPOROVICH – Energy and mass transfer in plant communities

2 - W.R. GARDNER, W.A. JURY and J. KNIGHT - Water uptake by vegetation.

Papers :

1 - Y. BOYER and S. de PARCEVAUX - Study of conditions leading to a stimulant effect of water stress on plant.

2 - E. RIPLEY and B. SAUGIER - Energy and mass exchange of a native grassland in Saskatchewan.

3 - J.P. CHIAPALE - A numerical model for estimating the modification of heat budget introduced by Hedges.

4 - A. HADAS - Water transfer to germinating seeds as affected by soil hydraulic properties and seed-water contact impedance.

5 - M. IQBAL, A.K. KHATRY and B. SEGDIN - Roughness effects of multiple windbreaks.

6 - R. LEMEUR and N.J. ROSENBERG - Reflectant induced modification of the variation balance for increased crop water use efficiency.

7 - F. KREITH and A. TAORI - The use of anti-transpirants to control water consumption in eco-systems - an experimental study of short-and longterm effectiveness of various transpiration - reducing chemicals.

8 Y, BELOT and D. GAUTHIER - Transport of micronic particles from atmosphere to foliar surfaces.

9 - D. STOJANOVIC, M. BOGDANOVIC and A. RASTOVIC - The coal ashes as substrate for plant growing.

SECTION V - POLLUTION OF SOIL, WATER IN THE SOIL AND VEGETATION
3 lectures.

1 - D.E. ELRICK, P.H. GROENEVELT and T.J.M. BLOM - Problems of chemical reaction and biological processes in soils.

2 - L. WARTENA - Prediction of soil-and ground water pollution.

3 - A. CHAMBERLAIN - Pollution in plant canopies.

V - DESIGN AND USE OF PHYTOTRONS IN CROP PRODUCTIVITY STUDIES

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Introduction

The design of a controlled plant environment facility should reflect its intended use. Of all possible uses, we consider the most important to be the study of the responses of crop plants to their environment. A complete understanding of crop behaviour must eventually replace the mixture of folk-lore and empiricism upon which most current agronomic practices are based.

In the natural environment, the principal physical factors that regulate crop growth are: the quantity of photosynthetically active and total shortwave radiation, the temperature, water vapor concentration and turbulence of the air, the water potential in the root zone, and the mineral concentration in the soil solution.

We cannot expect to understand a crop's response to these factors by studying the results of field experiments, for several reasons: Firstly, each factor fluctuates in an uncontrolled fashion, each with a different frequency. Secondly, plant responses are always non-linear; for example, doubling the light flux will not double the net carbon flux, the rate of dark respiration is not linearly related to temperature, the rate of extension growth is a non-linear function of water potential, and so on. Thirdly, the responses are highly interactive. Therefore, we can draw only very crude conclusions from attempts to relate the accumulated or averaged plant response to the averages of environmental parameters. This implies that "bioclimatology", as it is generally understood, is of very little help in understanding crop behavior. It also implies that simple phytotron experiments, in which one parameter is varied at a time, are not much better.

We believe that the most progress will be made by combining the experiments with computer simulations of crop behavior. This view is becoming more and more widely held amongst agronomists, but very few are attempting to put it into practice. It is obvious from even a cursory glance at the field that the best combination of simulation and experiment has not yet been found, and it will not be found until we have many more groups searching for it. In our view, the main goals of this meeting should be to encourage more people to get into this field, and to organize support for them.

USE OF PHYTOTRONS FOR MEASURING PLANT RESPONSE FUNCTIONS

A computer simulation of crop behavior consists basically of a set of environmental parameters which are allowed to vary in a known manner, a set of responses which are thought to regulate the plants behavior, and a set of logical relationships between the two, which we shall call the <u>response functions.</u> The advantage of simulation is that a very large number of possible combinations of plant and environment can be studied, many more than could ever be studied in the world's largest phytotron. The main disadvantage, when it is applied to biological systems, is that many of the response functions are unknown. In biology, the number of completely logical and proven response functions is extremely small, compared with those available in physics.

Take as an example the simulation of the effect of light on the photosynthetic rate of a crop, for various combinations of sun angle and canopy architecture. The physical side of the problem has been extensively studied. We can calculate the irradiance at the surface of every leaf in any crop canopy with an accuracy of 10% or better. However, the functional relationship between this irradiance and the photosynthetic rate of the leaf cannot be calculated by any logical method, since the mechanism of Leaf photosynthesis is still unknown. To make progress we have to *use* empirical relationships. This, in turn, means that we have to satisfy ourselves that the functions we use in the simulations do in fact apply to the leaves we are studying, and this we can do only by experiment.

These experiments can be done in controlled-environment chambers, but not in standard commercial chambers. The range of conditions which can be obtained in standard chambers is far smaller than outdoors, with the result that dangerous extrapolation of response functions occurs in the simulations. An even greater limitation is that some of the environmental factors which are known to be important are not controlled at all.

There are no technical problems in obtaining a sufficient range of control of all of the important environmental factors. The real problem is that, for the most part, the engineers have not been asked to design chambers in which good response functions can be determined. In our opinion, the extra expense involved in making good chambers is well worthwhile if the chambers are properly used, in combination with computer simulations, to predict the field responses of agricultural crops. There is no excuse for further proliferation of simple one-factor experiments on plants grown under completely unnatural conditions.

CONTROL REQUIREMENTS

One of us (Van Bevel, 1970) has recently published an analysis of the shortcomings of contemporary phytotron design for crop ecology studies, and we shall simply summarize the points made. We shall discuss only the aerial environment, since the provision of a realistic root environment (whatever that may be) seems to be beyond the state of the art at the present time.

In most contemporary phytotrons

1. The carbon dioxide concentration is unknown, or uncontrolled, or both, despite the fact that it is at least as important as the light level or temperature in determining the rate of plant growth. Plants can take up much more CO_2 than can enter through a hole in the chamber.

2. The light levels are too low, seldom exceeding 1/4 of direct sunlight, in terms of photosynthetically active radiation.

3. The flow of air around the leaves is too low, with the result that the natural action of the stomata, in regulating the exchange of H_2O and CO_2 by the leaf is masked by the resistance of the layer of air around the leaf.

4. No provision is made for the removal of water vapor. At natural levels of light, radiation, temperature, humidity and airspeed, plants transpire large quantities of water, which must be removed from the chamber.

5. The relative humidity of the air is controlled, whereas it is

the <u>absolute humidity</u> which determines the rate of transpiration, for a given energy input and resistance to water loss by the leaf.

We suggest that the following points be considered in new designs:

1. The CO2 concentration should be controlled by injecting CO2 during the diurnal period. It need not be controlled during the nocturnal period. For some experiments, it may need to be controlled at levels up to lc times the normal outside level (300ppm). The chamber must be designed so that the plants can be reached without contaminating the chamber with CO_2 from human breath.

2. Levels of photosynthetically active radiation should be comparable with daylight. In units of quantum flux density, which are the most relevant (Mc Cree, 1972), this is 2300 microeinsteins $.m^{-2}.s^{-1}$. The equivalent irradiance (energy flux density) is 500 W,m^{-2}. The waveband for both specifications is 400-700 nm. The spectral distribution within this waveband is irrelevant. The number of footcandles is also irrelevant.

Radiation outside the 400-700 nm waveband heats the plant. In the 700-3000 nm waveband, which makes up the rest of the natural solar radiation, leaves have a low absorptance, so that radiation in this waveband is relatively unimportant. Longwave (thermal) radiation is strongly absorbed. Therefore, a cooled barrier must be placed between the Lamps and the leaves. An air-cooled double-glass window is adequate when leaf temperatures below 10°C are not required. At sunlight levels of lighting the total radiant load on the chamber and, the leaves in it will be at least $lkW.m^{-2}$. An additional 2 or $3kW.m^{-2}$ of heating and cooling capacity is necessary for obtaining reasonable rates of change of temperature (say 2°C per minute).

3. The airspeed over the plants should be in the range 1-3 $m.s^{-1}$. The value is somewhat uncertain, since the turbulence in the chamber is likely to be less than that in the field. The transfer coefficient is probably sufficiently high if leaf temperatures are not more than 1°C greater than air temperature, in well-watered plants exposed to the maximum radiant load and the highest humidity available in the chamber.

4. The absolute humidity of the air (dewpoint) should be controlled by means of a large coil with good drainage. Dewpoints in the range 0 to 30°C are encountered outdoors, in various combinations with the air temperature. The dewpoint usually remains constant throughout the day, while the air temperature and therefore the relative humidity vary a great deal. Thus, control of the dewpoint is not only more logical but also simpler.

It is our belief that questions such as these, concerning what parameters should be controlled, and over what <u>range,</u> should be discussed more often than questions about the <u>accuracy</u> of control needed.

<u>EXAMPLES OF PLANT RESPONSE DATA</u>

1. <u>Comparison of gas exchange rates in natural and artificial environ, mants</u>

We grew a crop of soybean plants (Glycine max., var. "Lee") in a chamber which provided 2000 microeinsteins $.m^{-2}.s^{-1}$ of photosynthetically active radiation (PAR) from Lucalox lamps, and a CO_2 level which was constant at 320 ppm. The air temperature was 25°C during the 16 hours of illumination and 15°C during the nocturnal period. The absolute humidity was constant at 17 $g.m^{-3}$(dewpoint 20 C). The airspeed was 1.2 $m.s^{-1}$ above the canopy, which had a leaf area index (LAI) of 3.7.

The photoflux of CO_2 into the canopy was practically constant for the 16-hour period at 3.63 g per m^2 of ground area per hour. The skotoflux was also near-constant at -0.56 $g.m^{-2}.hr^{-1}$. Thus the net 24-hour or circadian flux was 54 $g.m^{-}.^{4}.day^{-1}$. This is the net CO_2 uptake of the whole plant mass, not just the leaves.

The well-known data of Loomis and Williams (1963) for the rate of accumulation of dry matter by crops growing outside show a maximum observed value of 38 g of dry matter per m_2 and day, the equivalent of 55 $g.m^{-2}.day^{-1}$ of CO_2.

Under the same conditions, we measured a rate of water loss by transpiration of 7.4 mm day-1, a figure that compares well with summer values for well-watered crops.

We conclude that, using normal current technology, it is quite possible to produce crops that assimilate and transpire at rates at least as great as those found outside. We would be interested to learn of comparable performance figures for the conventional phytotron. Figures such as these are a good measure of the ability of an installation and its management to produce data which are relevant to crop productivity.

2, Effect of light and ambient CO_2 level on assimilation and transpiration

Two separate studies were made of the effect of changes in the ambiant CO_2 level on rates of assimilation and transpiration of a soybean crop at an air temperature of 25C, humidity 17 $g.m^{-3}$ (dew-point 20 C), airspeed 1.2 $m.s^{-1}$, and a canopy LAI of about 4. In one test the PAR level was 2000 microeinsteins $.m^{-2}.s^{-1}$, and in the other it was 350, which is about that found in phytotrons with fluorescent lamps. The results are given in table :

EFFECT OF LIGHT AND CO_2 ON CO_2 AND H_2O FLUXES OF A SOYBEAN CROP

Light m einsteins $s^{-1}.m^{-2}$	Co2 ppm	Photoflux of CO2 $g.m^{-2}.hr^{-A}$, (assimilation)	Photoflux of ti20 $g.m^{-}.hr^{-1}$ (transpiration)
2000	300	3,63	463
	600	5,77	354
	1200	8.30	309
350	300	3.08	172
	600	3.43	139
	1200	3.94	110

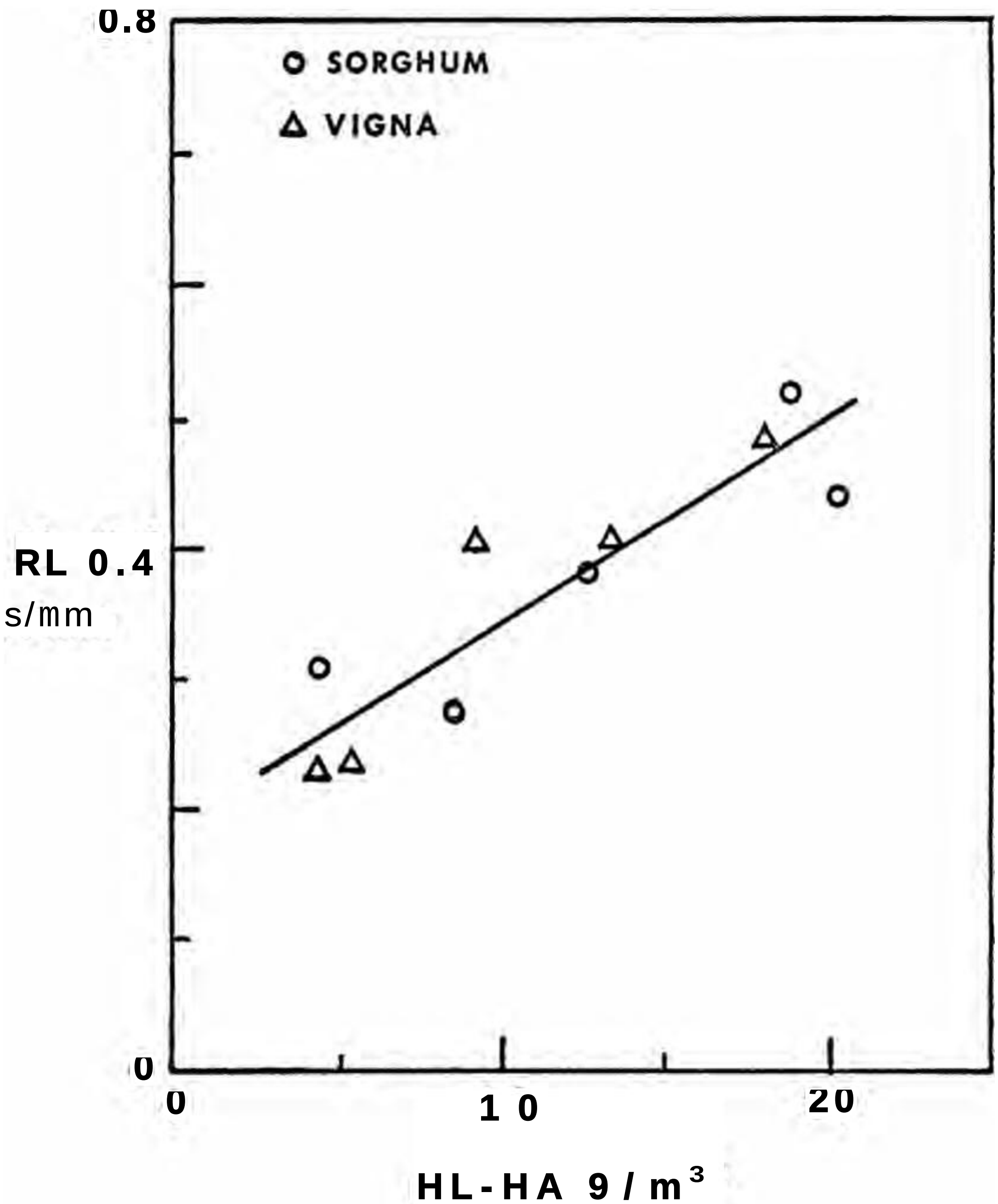

FIG. 1

They demonstrate some facts which are well known in plant physiology but not recognized in phytotron design. At the high light level, the assimilation rate was very sensitive to the ambient CO2 level. In the simple view, this is because the photosynthetic apparatus was not "saturated" with CO2 under these conditions. However, the transpiration rate decreased as the CO2 level increased. This indicates that the stomatal aperture was smaller, which would in turn affect the rate of assimilation. Both effects were smaller at the lower light level. We do not have time to discuss the computer model which has been built to describe all of these interactions in a logical fashion. We shall *use* the data simply to demonstrate that CO2 control cannot be neglected, even when studying only the water relations of plants.

3. Effect of absolute humidity on leaf diffusion resistance

In this test, the light level and CO2 concentration were held constant (900 microeinsteins.s^{-1}.m^{-2} and 230 ppm), and the air temperature and dewpoint were varied independently, in the range 26-40 C for the air and 5-34 C for the dewpoint. The leaves of well-watered plants were allowed to reach their equilibrium temperature (which fell in the range 22-38 C). Then the resistance to diffusion of water vapor (RL) was measured with a porometer.

This resistance is a complex function of the leaf water potential, which in turn depends on the soil water potential, the resistance to water flow within the plant and the rate of transpiration. Once again we need a computer model. However, it turned out (fig, 1) that RL was roughly linearly related to the difference in absolute humidity between the inside and the outside of the leaf (HL -HA), independent of the particular combination of temperature and humidity used. Also, the same relationship held for both of the plants tested, Sorghum bicolor L., Moench and Vigna sinensis L. Endl. We claim no general validity for this relationship, but are using the results to show the usefulness of absolute humidity control.

CONCLUSIONS

We realize that the requirements set out here will increase the complexity and cost of a phytotron installation. This leads us to suggest that not only the technical but also the managerial side of the operation needs to be revised.

The super installations of today permit many simultaneous experiments, in a multitude of separate chambers. One could almost speak of a proliferation of chambers, projects, scientists and (unfortunately) data. This individualistic, fragmented and reductionist approach is out of tune with the times. In other fields of scientific endeavor, increasing use is being made of interdisciplinary teams of theoreticians and experimentalists. In ecophysiology, the cost of field work has mounted to the point where individual studies are practically out of the question. We believe it is time that the same criteria be applied to plant physiological studies in phytotrons. Let us encourage people to start using the logical framework of computer simulations, instead of guesswork, in their extrapolations from the phytotron to the field, and to talk not of plant responses but of response *notions.

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VI - NATIONAL SCIENCE FOUNDATION PROJECT (RANN PROJECT)

We have received the following information from Professor P.J. KRAMER (Duke University -Durham N.C. 27706 USA) in his letter of January 21, 1975, which continues along the lines set in the preceding paper from Dr Van Bavel.

Prof. Kramer wrote:"We are busy with what we call our RANN project because it was financed by a grant from the division of the National Science Foundation often called RANN (Research Applied to National Needs). I suppose it is the most intensive study of "Phytotronics" thus far made. It involves an intensive study of plant growth in our phytotrons as compared with out-of-doors accompanied by measurements of environmental factors and physiological processes such as CO_2 uptake, transpiration, stomatal opening, and leaf water potential. We also are making a study of the cost in time and money of the two types of research".

HAS a by-product we are learning quite a bit about deficiencies in our operations. These involve overcrowding of plants, CO_2 deficiency in the growth chambers, and lack of uniformity in watering. I am enclosing some comments on the watering problem which might be suitable for the Newsletter."

UNIFORM WATERING OF POTTED PLANTS

Users of controlled environment facilities such as plant growth chambers and phytotrons assume that their plants are being grown in carefully controlled, reproducible environments. However, this situation does not always exist. The difficulty of maintaining a constant concentration of CO_2 in chambers filled with large plants is fairly well known. We also have found evidence of lack of uniformity in supplying water and nutrient solution to plants. Sometimes this results from careless application and sometimes it results from difficulty in reaching the pots in the center of a group of large plants. Occasionally, a layer of algae develops on the surface of the rooting medium which hinders penetration of water.

system similar to those often used in commercial greenhouses. This system consists of plastic supply tubes laid between the rows of pots, from which small delivery tubes run to each pot. The delivery tubes are connected to the plastic supply tubes by inserting them into holes punched in the supply tubes with a special, tool_ supplied by the manufacturer. The delivery tubes usually end in weights to hold them in place in the pots, and the weights contain holes through which the liquid trickles out onto the rooting medium. For larger pots the delivery tubes often are attached to plastic stakes thrust into the rooting medium which contain holes from which liquid is sprayed out over the surface of root medium. The nozzles and supply tubes used by us were obtained from Chapin Watermatics Inc, Watertown, New-York.

The quantity of water or nutrient solution dispensed is controlled by an electric timer which operates a solenoid valve in the supply line. For small pots which require only a few minutes of watering per application a adjustable cam-type timer is used which makes a complete revolution each time that water is to be applied. The cam timer is controlled by a 24 hour time clock set to turn the cam timer on for each watering period and keep it on long enough to complete one revolution. The amount of liquid applied is controlled by adjusting the Length of time the cam is in the "on" position. For larger pots where water is applied for longer periods an ordinary time clock is satisfactory. We generally apply nutrient solution until it drips freely from the pots, because it is much easier to apply an excess which drains off than to determine the exact amount required to wet the root medium to field capacity. Also the drainage of excess solution prevents accumulation of salt. The frequency of application varies from one to four times per day, depending on the size of the pots and plants and atmospheric conditions.

We first tried the system on lettuce growing in 12.5 cm pots of gravel and vermiculite in a small growth chamber, applying about 50mI of modified half strength Hoagland's solution per pot, four times a day from the time the seed was planted until the final harvest at 28 or 35 days. The system was then tested on a crop of large corn plants in a large growth chamber. During the summer it was used out-of doors on over 300 25 cm pots filled with vermiculite gravel mixture in which cotton and soybean plants were grown to maturity. The small water storage capacity of the root medium and high rate of water loss made uniform and frequent watering necessary. If a plant had been missed for even a single day it would have wilted severely and perhaps even have died. However, the system worked almost perfectly for about five months. It never failed to water the plants when the time clock called for it although once or twice it failed to close properly and flooded the pots. This was no troublesome because we always watered the plants until surplus solution dripped from the drain holes of the pots. The vermiculite-gravel mixture quickly returns to "pot field capacity" after watering so aeration is not a problem and the solution flowing through the pots removes any surplus salt. No liquid was applied other than the half strength Hoagland's solution.

The control system could be modified in various ways. For example it could supply nutrient solution at one time and water at another time by providing two sources and a pair of valves controlled by a time clock to switch from one to the other. Its use for pots on trucks which are being moved daily is more difficult, but not impossible.

All of the pots on one truck can be supplied from one manifold equipped with a special connection to quickly connect it to or disconnect it from a supply line.

After rather extensive use we feel that mechanized watering is significantly more uniform than manual watering and ought to be used more extensively in controlled environment facilities. The application of this system to our requirements was made by Mr. J.N. McQUAY and Mr J.L. HITE of the Duke unit of the Southeastern Plant Environment Laboratories.

[VII - THE WROCLAW HYDROPONIC CULTURES

Paper distributed during International Horticultural Congress at Warsaw (Poland) in September 1974
by Dr Z. GUMINSKA, Institute of Botany - Wroclaw University - Poland.

In previous work(4,5) the author has shown that the upper part of roots is particularly sensitive to the access of air. The air supplied to the lower portions of the root does not compensate for its deficiency in the upper part. It has also been stated that, depending upon the conditions given, the roots may produce two kinds of root hairs: "respiratory" and those which take up water with mineral salts. For this reason nutrient solutions should be maintained on as constant a level as possible.

In view of the above mentioned paper the Gericke hydroponics(3) have been modified by applying some holes to let the outside air in the air space between the net on which the litter with plants was laid an nutrient solution. The characteristics features of the Wroclaw hydroponic cultures(6) are the following :

1. there is a 3 cm air-space between the surface of the nutrient solution and the seedbed7

2. the solution is non-circulating and not renewed during the culture, but only refilled and replenished according to consumption?

3. the substrate which provides the seedbed as well as the nutrient solution contain biologically active humates.

The purpose of the further experiments was to investigate:

1, the most suitable composition of the substrate,
2. the most suitable composition of the nutrient solution.

1/ The studies on the composition of the substrate are closely related to the investigations conducted by the author and S. Guminski on the effects of humus compounds. In view of these investigations special attention has been paid to materials containing biologically active humates. It has appeared that the hydration properties of peat as well as the sorptive and ion-exchanging abilities of soluble humus compounds contained in peat and brown coal protect the plant against dangerous changes in the concentration of the nutrient solution that take place in hydroponic cultures. It has been found that a mixture of slag with sphagnum peat or peat with brown coal or peat with coke are good substrates, while peat alone is not advantageous, since its structure is too compact and thus does not guarantee proper aeration. On the other hand, coal alone dries too rapidly and therefore is not a good habitat for the roots (15,17).

Very acidic peat must first be alcalyzed, but liming should be avoided. The best results are obtained by alcalyzing the peat with NaOH (10). The negative effects of liming on the structure of the substrate may be explained by the results obtained by Eilenberg (1), and by investigations conducted by Flaig (2) and Guminski (19) on humate-metal complexes.

The humate washed from the substrate make it possible to retain iron in the solution (9, 17). In the absence of humates and in a nutrient solution which is never renewed the iron is precipitated entirely. The humates control the uptake of mineral salts, especially in higher concentrations of nutrient solution; they perform a protective role when copper and other ions are present in excess, and they interfere when the pH of the solution differs from the optimum (13). The presence of humates in the nutrient solution is not without influence on the microorganisms, either (18).

The investigations performed made it possible to state that the colour of the substrate is also an important factor in hydroponic cultures. A white substrate accelerates the vegetation in deficiency of light. A bioinduction effect was manifested in cultures of tomato plants; when placed on a white substrate in January, they produced fruit 2 weeks earlier than the plants of the same age but growing on a dark substrate (7). This phenomenon is related with the function of the spongy parenchyma (22).

2/ The best results have been obtained by applying a nutrient solution consisting of the following components in grams per 1 litre of water :

superphosphate (20 % P_2O_5)	0,8
potassium nitrate	0,7
calcium nitrate	0,7
magnesium sulphate	0,3
green vitriol	0,1

supplemented with manganese, copper, zinc, boron and molybdenum, given in doses 0,6 mg each.

In summer the N : P205 K2O ratio amounts to 1:0,8:1,5 and in winter 1:0,8:2,25 respectively. Thus starting from 1.IX a nutrient solution containing a greater amount of potassium must be supplemented with either 0,35 g KCl or 0,3 g K2SO4 per 1 litre. The pH of this solution should be 6,5, but it must be controlled, either by phosphoric acid for acidification or by NaOH for alcalization, respectively. The quantitative and qualitative effects of the composition of nutrient solution on the growth and development of plants was investigated (16). Nitrogen given in form of nitrates brought the best results. Microbiological investigations of hydroponic cultures, currently in progress, have shown that when nitrogen was applied in the form of ammonium, even partially, then the number of bacteria grew rapidly and the development of higher plants was inhibited. Potassium should be applied in the form of nitrate (KNO_3), but in the presence of humate KC1 is *also* good, the worst effects being observed with K_2SO_4. It has been found, more-over, that the addition of KNO_3 (up to 1,2 g/1) to the nutrient solution increases the yield of green matter and the percentage of long shoots in asparagus (15)7 in autumn an advantageous effect has been obtained by doubling the calcium content.

Since the investigations of the above mentioned nutrient solutions have shown a high tolerance of carnations to phosphate fertilizers and since a close relationship between the phosphorus uptake and the intensity of light has been found in experiments with tomato plants, special studies on phosphorus fertilization were initiated. The *experiments* performed so far have shown that humate exerts a positive effect on both in-sufficient and toxic doses of phosphorus which was not observed at an optimum dose of this element. The effect of humate increases with the increasing intensity of light.

The most advantageous dose of $Fe_2(SO_4)_3$ is 0,1 g/1; if, however iron is given in chelate form, its dose should be 5 times lower.

In summer when the light is intense enough good effects have been obtained by applying a 10 times higher dose of either molybdenum or boron or copper, but always only one of these elements. When the light is insufficient, e.g. in autumn, an increased dose of one of these elements exerts toxic effects.

As long as the plant is small and does not reach the nutrient solution with its roots, the substrate should be sprinkled with the nutrient solution at double concentration (8). When the plant roots are already dipped in the nutrient solution, the substrate should be kept moist sprinkling with water exclusively, and the nutrient solution maintained at a constant level by adding solution when necessary.

To make the plant feeding more precise, the optimum doses have been determined per plant per year. It should be noted that 80 % of the annual dose is applied in the vegetation season, i.e. from March 1 to September 1 and the remaining 20 % starting from September 1 to march 1. The entire dose is divided into months and subdivided into *weeks,* e.g. carnations require 25 g of the above mixture (11), Asparagus sprengeri 50 g (15) and tomato plants produce the highest crops (5 inflorescences in 5 months) with a dose of 75 g, while gladiolus requires 2,5 g (14) like other bulbiferous plants.

In view of the results obtained by a group of Wroclavian physiologists who are studying the application of detergents (21) the effect of these substances on various hydroponic cultures has been investigated. In the initial stage, single doses of detergents have distinctly stimulated the vegetative development of plants, but when applied more frequently (every 4 weeks) they diminished the yield of fruit by about 30 % in tomato plants and the size of flowers in carnations. The above results are in good agreement with the investigations conducted in the Department of Plant Physiology, which have shown that detergents stimulate the uptake of nitrogen, phosphorus, and iron but inhibit the accumulation of potassium. A frequent application of detergents has most distinctly affected tomato plants, which are particularly sensitive to potassium fertilization.

From the paper by Guminski and Badurowa (20) it follows that CO_2

when passed through the nutrient solution inhibited the growth of plants. Thus the question arises whether an increase in the CO_2 content of the greenhouse air will exert a positive effect on plants growing in hydroponic cultures, or whether CO_2, by combining with water will bring negative results. Experiments have shown that plants growing in the ground and in hydroponics as well as in water cultures responded positively to a ten-fold increase in CO_2 content, compared with control plants growing under normal conditions (12).

In comparing the Wroclavian method of hydroponic plant culture with the non-hydroponic culture of plants in various substrates e.g. in a mixture of brown coal with peat, it may be said that with healthy plants equal crops may be obtained. The Wroclavian hydroponic method requires more expensive equipment than non-hydroponic substrate cultures, since besides water-tight reservoirs a raised net and close-mesh nylon are required. This investment, however, brings the following advantages :

1) The blossoming and fructification are accelerated due to good aeration of the upper portion of the plants (17):

2) the renewal of a substrate 10 cm thick is much cheaper and less time consuming than the renewal of a layer of substrate 50 cm thick,

3) the water balance is better

4) plants infected with fungi perish much faster, within one month - i.e. the selection proceeds very fast, while in substrates as well as in soil infected plants survive for several months.

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VIII - A CO2 MONITORING AND CONTROL SYSTEM FOR PLANT GROWTH CHAMBERS AND GREENHOUSES

Paper sent by Dr D.T. PATTERSON and Dr J.L. HITE
Botany Department - Phytotron. Durham 27706 N.C. USA

Most plant growth chambers are equipped with some means of introducing air from outside to present the CO2 concentration from falling to excessively low levels. However, observations in both units of the Southeastern Plant Environment Laboratories (SEPEL) indicate that these provisions are totally insufficient for growth chambers filled with large plants. For example, the A-chambers of SEPEL, which are 3.65 x 2.43 x 2.13 m and contain 18.9 m^3 of air, have a theoretical input of fresh or makeup air sufficient to produce a turnover of approximately 1 % of their volume per minute. Nevertheless, a crop of cotton plants can deplete the CO2 concentration of an A-chamber to 150 ppm and corn to 50 ppm although the outside air contains 350 ppm. Materially increasing the rate of introduction of fresh air increases the load on the air conditioning equipment and decreases the precision of control of the chamber environment. Therefore, the most practicable method of maintaining the CO2 concentration at a desired level is by controlled injection of CO2.

A system which will continuously monitor the CO2 concentration in several growth chambers and greenhouses has recently been installed at the Duke University unit of SEPTA. The system also provides automatic CO_2 supplementation of the chamber and greenhouse atmosphere to maintain CO_2 at normal levels.

Air samples are drawn from the chambers and greenhouses through polypropylene tubing (Impolene, Imperial Eastman) to a central control panel. At the panel_ each sample line is fitted with a three-way solenoid valve (Skinner model V54 DA 2075) which further connects it to two separate manifolds. When the solenoids are not energized the sample air passes into an exhaust manifold and exhausts through a large pump (Gast model 0822-V2) which runs continuously to purge the sample lines and prevent contamination of one sample by the previous sample. When a solenoid is energized it diverts the air sample into the sample manifold which is connected to a small diaphragm pump (Bantam CynaVac model 7064). This pump draws air from only one sampling station at a time, depending on which solenoid is energized, and pumps the air sample through the CO_2 analyzer (Beckman model 864). A strip baro recorder (Honeywell-Brown Electronik) monitors the signal from the CO_2 analyzer,

The sampling sequence and timing are controlled by a stepper switch (Automatic Electric type 45) which is activated by a cam timer (Harco 2 gang repeat cycle timer) every two minutes. The stepper switch energizes sequentially the three-day solenoids thus diverting samples from each station consecutively into the analyzer. Each sample station is monitored for a 2 minute interval during each cycle of the stepper. At present, three chambers, three greenhouses and one air duct are monitored, the air from each being sampled every 14 minutes. Manual override switches allow continuous monitoring of any one point by bypassing the cam timer and holding the stepper switch on a particular point.

A two-day normally closed solenoid valve (Sporlan W3P1) at each chamber and greenhouse controls the input of supplemental CO_2 from a compressed gas cylinder. Each valve is wired through both a cam-activated switch on the recorder pen drive mechanism and the stepper switch with controls the three-way solenoids on the sample lines. When the signal from the CO_2 analyzer falls below the set point, the contacts on the recorder cam switch close, allowing current to pass through the closed contacts of the stepper switch. This energizes the two-way solenoid valve at the corresponding sampling station. Supplemental CO_2 is then added until the CO_2 level reaches the set point or the stepper switch breaks the circuit. The maximum time for CO_2 input is the same as the sampling time, two minutes on each cycle. The input of supplemental CO_2 is further controlled at the inlet to each chamber and greenhouse by a flow meter and needle valve. The system requires periodic manual adjustment of the needle valves to provide an adequate supply of CO_2 during the two minute sample interval at each chamber or greenhouse.

Since some of the chambers operate at high humidities and at temperatures 5 to 8°C above room temperature, condensation can occur in the sample lines. In order to avoid condensation it was necessary to either dry the air or raise the temperature of the sample lines above the dew point of the air samples. Because a dew point hygrometer (F.G and G model. 880) is installed periodically in the system to monitor humidity, we decided to heat the sample lines rather than dry the air. This was accomplished by running a resistance heating wire (copper chromium 1,5 ohm per m) inside each sample line and connecting it through a rheostat to line current (115 v) to supply 7,5 watts per m.

In our experience the system provides control within ± 10 ppm CO_2 of the set point. It is limited as a control system in that all of the chambers and greenhouses must be controlled at the same CO_2 concentration. The number of sites that can be controlled is also somewhat limited by the time required to sample each station. Although a 2 minute sample interval is now used, this could be reduced to about 45 seconds if it were necessary to control a larger number of chambers and greenhouses.

The brand names and model numbers Listed herein are merely intended to indicate the type of equipment which can be used. Other makes and models might be equally suitable.

IX - NEWS FOR PHYTOTRONISTS

a) ACTIVITY OF ESNA IN 1974

Those who would like either to obtain information about this European Society of Nuclear Methods in Agriculture or to participate in the very interesting work of the various working groups, should write to the Secretariat.

Address : ESNA Secretariat, P.O. Box 48, WAGENINGEN (The Netherlands)

1) In January 1975 the proceedings of working group n° 2 was published - "Radiation induced stimulation effects in plants." This group proposed to undertake stimulation experiments in comparable plants.

The first experiments done with : maize, sugar beet, rye grass, pepper, barley, tomatoes and sunflower, gave results which were often no reproducible. A common program in a laboratory and in the field was also undertaken in 1975 based on a protocol coordinated by several laboratories : Hannover (ERG), Novi Sad (Yugoslavia), Munich (ERG) and Godollo (Hungary).

Thefian chosen for the new experiments was based on :

- Plant test : early red radish (Hungarian sowing seeds)
- Irradiation : 60 radiation source doses : 1500, 3000 and 6000rad.
  dose rate : 500 rad/hour,
- Phytotron conditions : Temperature 20 (± 1 - 2°C)
  humidity 60 - 70 % HR
  Photoperiod 12 hour day and 12 hour night
  Light intensity : 12.000 Lux (white luminescent tubes)
- Nutrition : uniform soil (50 % peat and 50 % clay) from Hannover,
  Water capacity 60 - 70 %
- Irrigation every second day with tap water of 20°C
- Pots :plastic 18x18 from Hannover, Capacity 4 liters.
  Twice weekly change of pots' position
- Repetition : 6
- Sowing ; 9 seeds per vessel, thinned out to 5 plants per vase.
  Sowing 24 hours after irradiation- moisture of seeds 12-14 %.
  Depth of sowing - 3 cm.
- Harvest : 35 days after seeding.

Tests parameters in phytotron

- Rate and percentage of sprouting
- Fresh weight and dry weight of each organ individually by plant (leaf-root ratio)
- volume of roots
- vitamin C content of the root
- Mono and total carbohydrate content of the root

Observation tests to do in the field :

On 50 %4the plants the same determinations as done in the Phytotron.

The other plants should be cultivated until maturity of the seeds in the following way :

- size of the plot : 2,5 x 0,6 meters
- sowing interspaced : 5 x 30 cm (100 plants)
- number of repetitions : 5
- to ensure closed material, encircled by bordering
- harvest 35 days after sowing (thinned out to conserve 10 cm between plants)

In the plants thinned out the following properties are controlled:

1. the rate of blossoming (average of blossoming since 50 % of the plants are in blossom)
2. yield of seeds per plant
3, weight of 1000 seeds.

x

2) In. January 1975 the working group <u>"Nuclear Techniques in the study of soil plant relationships"</u> published an account of its meeting in Bucharest in September 1974 (100 mimeographed pages). Below is the table of contents :

Vth Annual Report of the Assembly of ESNA

- F. VAN DORP, J. SINNAEVE - Synthetic ion-exchanger resins as a growth medium for plants in ion uptake studies.

- O. PETRESCU, G. STANCIULESCU, M. BOLOGA, M. PODOLEANU - Research done in Rumania on nutrition and fertilization of tomatoes with azote, using fertilizer marked with 15 N (in French).

- E.P. PAPANICOLAOU, V.D. SKARLOU and C.G. APOSTOLAKIS - Effect of placement method of P fertilizer on bean production, bean composition, fertilizer utilisation and N fixation.

- G. E. SUTEU - Rates of the soil organic matter N mineralisation and of the N losses from the soil and of the N fixation by the leguminous plants evaluated by the 15 N technique in the pot *experiments.*

- G.E. SUTET,J, J. RODERBOURG, C.R. KIEK and A. SQUALLI - On the possibility of determining by the intermediary of 15 N the mineralization of N, the losses of mineralized N and of N originating in the atmosphere for vegetable plants (in French).

- A. DOMNICZ - Translocation of 32 P and 99 Mo by foliar application.

x

b) TRAITE DE L'ECLAIRAGE NATUREL DES SERRES ET ABRIS POUR VEGETAUX

R. DOGNIAUX and A. NISEN with the collaboration of the sub-Commission "Natural Lighting in Greenhouses" of the Belgian National Committee on Lighting have just published this large volume of 198 21 x 30 cm. pages with illustrations and tables. (Editor : Duculot - Genoux, Belgium, 650 Belgian Francs).

As Professor Lucien Morren very rightly mentions in the book's preface, "This treatise is a work whose originality must be strongly emphasized." Indeed, it is considered to be the first multi-disciplinary treatise written in French which combines "so much information and so many directions for a rational exploitation of light in greenhouses and shelters." It provides useful and even indispensable precisions at least in the following fields : agronomy and agricultural construction, meteorology, economy, lighting as much for teaching purposes, as for practice. Many ideas and practical conclusions can be found mainly concerning the use of glass and plastic material and their efficiency from the stand point of energy balance, by reducing supplies needed or by heat loss, with its repercussion on light balance.

Although elaborated for the particular conditions in Belgium, this treatise can be applied actually to the climatic conditions of all countries situated between 44 and 56 degrees latitude, in other words where greenhouses and shelters are most often used.

This work is particularly designed for horticultural and agricultural technicians, for schools and groups interested by the construction of greenhouses and shelters adapted to optimal culture conditions under given climatic conditions, for builders of these greenhouses and shelters, for producers - distributers of frame-work and covering materials, for specialists in air conditioning as well as architects and researchers confronted with specific problems of building experimental greenhouses.

We can only congratulate the authors for this remarkable book and hope that it will soon become an international reference given the mass of information presented, and an expose which is clear, concise and eminently well synthesized, attesting to the competence of the authors and providing easy reading for all those interested in these problems, even if their knowledge of French is limited.

C) NEW BOOKS

- Traite de 1'eclairage natural des serres at abris pour vegetaux. R. DOGNIAUX at A. NISEN - Ed. Duculot Gembloux, Belgique. 198 pages 131 diagrams and 48 tables. 1975, 650 Belgian Francs.
- The Life Process - J.A.V. BUTLER, London, George ALLEN and UNWIN, 1970. 256 pages.
- Nucleus and Cytoplasm - M. HARRIS, Oxford-Clarendon Press, 3 ed. XIV, 1974, 186 pages.
- Climate-diagram Maps - H. WALTER, E. HARNICKELL, O. MUELLER, DOMBOIS Berlin-Springer-Verlag, 36 pages, 1974, 72 D.M.
- Perspectives of Biophysical Ecology - Ed. GATES' D.M., SCHMERL R.B. 1974, 700 pages, 225 diagrams, 85,30 D.M
- Optimisation de /a repartition des ressources en eau - C. PARVULESCU Ed. Cebedoc, 3 Bd Frere Orban B. 4000 Li6ge, Belgique, 120 pages, 20 diagrams, 14 tables, 37 ref. 1975, 420 Belgian Francs.
- Les probremes de I'environnement. Ed. CEBEDOC, Li6ge, 80 pag s, 16 diagrams, 1974, 340 Belgian Francs.
- La germination des semences R. CHAUSSAT et Y. LE DEUNFF, Ed. Gauthier Villars, 1975, 232 pages.
- Les veg4taux d'ornement en conteneur, techniques de production et commercialisation - E. HENRY, Ed. Horticalor BP 6 - 69604 Villeur-banne Croix Luizet (France).
- French-English Horticultural Dictionary - Commonwealth Agricultural Bureaux Farnham House - Farnham Royal Slough SL 2-3 BN - Great Britain. χ 5,00.
- General Climatology - H.J. CRICHFIELD. Prentice Hall Inc. New York 1974, 3e Ed, 446 p.
- Introduction to Environmental Science and Technology - G. MASTERS Ed. John Wiley and Sons, 1974, 404 p.
- Proceedings of the First International Congress of Ecology, Wage-ningen Posthus 4, Netherlands, 1974, 414 p.

- Vocabulaire d'ecologie - Ph. DAGET et M. GODRON, Ed. Hachette, Paris 1974, 273 p. 20 French Francs.

- Annual Report and Accounts 1974 - Agricultural Research Council of Rhodesia - P.O. Box 8108 - Causeway, Salisbury, Rhodesia.

- Ecologie du developpement et Phytogeographie - Problemes de 1' Extreme-Orient Sovi6tique - CL. MATRON (mimeo) 1975, 48 pp. Faculte des Sciences de Poitiers - France,

d) <u>ARTICLES OF INTEREST TO PHYTOTRONISTS</u>

At the request of certain readers who live far from urban centers we bring to their attention several articles which might interest them or render service to them.

- R.S. ALBERTE and all. - Composition and activity of the Photosynthetic apparatus in temperature sensitive mutants of higher plants. Proc. Nat. Acad. Sc. USA, Vol. 71, N° 6, June 1974, pp.2414-2418.

- J.P. HESKETH and H. HELLMERS - Floral initiation in four plant species growing in CO2 enriched air - Environ. Control in Biol. II, n° 2, 1973, pp. 1151-53.

- J.M. Mc KINION and all. - Analysis of the exponential growth equation-Crop Science, Vol, 14, July-August 1974, pP.549-551.

- D.N. BAKER and all. - Simulation of growth and yield in Cotton, Crop Science, Vol. 12, July-August 1972, pp. 431-435 and 436-439.

- J.D. HESKETH and all. - temperature control in time intervals between vegetative and reproductive events in Soybeans - Crop Science, Vol. 13, Marsh-April 1973, pp. 250-254.

- J.W. JONES and all- Development of a nitrogen balance for Cotton growth models : a first approximation - Crop Science, Vol. 14, July-August 1974, pp. 541-546.

- R.F. COLWICK and H.D. BOWEN - Modeling Cotton production systems from seedbed to market 1974, Beltwide Cotton Production Research Conference Proceedings.

- J.W. JONES and all. - Analysis of simcot : Nitrogen and growth 1974, Beltwide Cotton production Research Conference Proceedings.

- J.M. Mc KINION and all. - Analysis of Simcot : Photosynthesis and growth 1974, Beltwide Cotton Production Research Conference Proceedings.

- G.J. HOFFMAN and S.L. RAWLINS - Design and performance of sunlit climate chambers. Transactions of the ASAE, Vol. 13, n° 5, 1970, pp. 656-660.

- C,J. PHENE and all. - Measuring soil metric potential in situ by sensing heat dissipation within a porous body - Soil Science Soc. America Proceedings, Vol. 35, n° 1, Jan-Feb. 1971, pp. 27-33 and n° 2, March-April 1971, pp. 225-229.

- C.J. PHENE and all. - Controlling automated irrigation with soil. matric potential sensor - Transactions of the ASAE, Vol. 16, n° 4, 1973, pp. 773-776.

- L. ROUSSEL - La oomplessa influenza della Luce sullo sviIuppo delLe plantule, latifoglie e conifere - Annali dell'Academia Itaiiana di Scienze Forestaii, vol. 22, 1973, pp. 269-286 (Resume en frangais).

- L. ROUSSEL - Entropie, syIvicuiture et ecoiogie - R.F.F., Vol. 26, n° 2, 1974. pp. 130-134.

- R, GASSER - La mesure des faibles vitesses de lair dans *les* locaux climatises. Revue technique Sulzer, n° 2, 1974. pp. 1-13.

- R.H. TAYLOR - Plant growth chambers - Laboratory Practice, Vol. 20, n° 9, Sept, 1971,

- P,S. HAMMES and E.A. BEYERS - Localization of the photoperiodic perception in potatoes - Potato Res., 16, 1973, pp. 68-72.

- P.C. NEL and E.A. BEYERS - The effect of benfluarin on the growth and yield of tobacco - Agroplantae, 6, 1974, pp. 11-16.

- R. IMPENS - Presence de plomb dans l'environnement. Annales de Gembloux, 1974, n° 3, pp. 173-185.

- A. NISEN - Evolution et prospective des cultures protegees en Europe, Annales de Gembloux, 1974, n° 1, pp. 39-53.

- J. DUBOIS - Perspectives nouvelles en amelioration des plantes Annales de Gembloux, 1974, n° 2, pp. 105-118.

- R. Paul – L'absorption foliarire du dioxide de soufre atmospherique et son utilization eventuelle par la plante. Annales de Gemblox, 1974, no 2, pp 95-103.

- P. STICKLER – Einsparen von heizkosten, S.F.G Reihe heft 16, 1974.

- E.D. SCHULZE and all. - The role of air humidity and leaf temperature in controlling stomatal resistance of Prunus armeniaca L. under desert conditions. I - A simulation of the daily course of stomatal resistance. Oecologia (Berl.) 1974 - 17 pp 159-170.

- 0.L. LANGE and all. - The temperature related photosynthetic capacity of plants under desert conditions - II. Possible controlling mechanisms for the seasonal changes of the Photosynthetic response to temperature - Oecologia (Berl.) 1975, 18, pp. 45-53.

E.D. SCHULZE and all. Stomatal responses to changes in temperature at increasing water stress - Planta (Berl.) 1973, 110, pp 29-42.

- J. BURRING - Vergleichende Untersuchungen uber die Gerwinnung stark bestockten Pflanzenmaterials bei Arten von Futtergrasern unter kunstlicht (Leuchtstofflampen Halogenmet alIdampf lampe 100:1c) - Arch. Zuchtungsforsch. Berlin, 1974, Band 4, heft 1, PP. 57-64.

R.J. SUMMERFIELD and all. - Versatile irrigation systems for controlled environment growth chambers - Journal of Horticultural Science, Vol. 49, n° 2, April 1974, pp. 161-166.

- J.O. RIELEY and R.J. SUMMERFIELD - The use of inert polymers in hydroponic studies - Plant and Soil, 1972, vol. 37, no 1, pp. 183-185,

- R. AIMI and Y. HANAMI Automatic program control of environment condition by feedback of biological response to a self regulating system of environment control - Environ-Control in Biol. 1973, Vol. 11, no 2, pp. 65-68.

- D.G. BARBEE and all. - A review categorizing engineering design techniques of plant environmental simulators - J. Agric. Eng. Res., 1973, Vol. 3.8, pp. 13-29.

- R. JACQUES et A. LECHARNY - Lumiere et croissance des tiges - Lux, 1975, n° 81, p. 26.

- P. LEMAIGRE-VOREAUX - Les nouvelles lampes c d6charge et I'eclai rage suppl4mentaire des piantes - Lux, 1975, n° 81, pp. 24-25.

- L. JUGE L'4clairage en Horticulture - Lux, 1975, n° 81, pp. 21-23.

- L. ROUSSEL - Quelques aspects des recherches de photologie forestieres - Lux, n° 81, pp. 27-28.

- V. SODERSTROM Influence of soil temperature on conifer plant growth Pilot studies in the Laboratory - Sveriges Skogsvardsforlunds Tidskrift 1974, nr 5-6.

e) <u>CLIMATE LABORATORY NEWSLETTER N° 4, NOVEMBER 1974.</u>

N° 4 of this New Zealand journal contains the following news :

1 - The founder of the Palmerston North Phytotron, Dr K.J. Mitchell, has been named to a new position : Director of Research in the Water and Soil Division, Ministry of work and Development, after 20 years of research and the direction of the Division of Plant Physiology. We wish him much success in this new endeavour which attests to the esteem in which his scientific and human qualities are held.

2 - The use of space in the Phytotron of Palmerston North was the following for the period from May 2 to November 1974 :

Department of Scientific and Industrial Research :

Grasslands	18,1 %
Entomology division	0,3
Crop Research division	10,2
Massey University	33,6
Forest.division	33,2
Private enterprise	4,6
	100 %

3 - In equipping the Phytotron, control of carbonic gas between environment and 900 ppm is operating satisfactorily.

4 - Description of 9 new research projects being carried out in the Palmerston North Phytotron:

5 - Report of experiments concluded :

• Root Formation in stem cuttings of Radiata Pine by R.J.CAMERON and D.A. ROOK.

• Influence of temperature change on wood formation in Pinus radiation grown in controlled environments by P.A. *JENKINS*.

• The effects of diurnal and permanent water stress on the critical stage of reproductive development of wheat by D.R. WILSON.

f) EVENTS, MEETINGS AND EXHIBITIONS PLANNED

1975 - July 3-10, Leningrad (USSR)
12th International Botanical Congress. At all includes 18 sections. In section 10 there is symposium n° 7 • Phytotronics.
Organizers : A.F. KLESHNIN (USSR), V.M. LEMAN (USSR). Chairman F.W. WENT (USA).

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

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

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

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

1975 - August 18-23 - Copenhagen (Denmark)
Symposium on propagation problems in Arboriculture (ISHS)
Information : Prof. A KLOUGART - Dept of Hortic. Rolighedsvej 23 DK-1958 - Copenhagen. Denmark.

1975 - August 21-27 - Moscow (USSR)
VIIIth International Congress of plant protection

Information : Secretariat of the Organizing Committee 1/11 - Orlikov per. - 107139 Moscow 8-139 USSR

1975 - August 23-31 - Goteborg (Sweden)
International Conference Garden Center I.G.A.

Inquiries : I.G.A. Conference c/o Svenska Massan Stiffelse Skanegatan 26 S412-5I Goteborg, Sweden.

1975 - August 31-September 5, Nantes (France)
Florexpo Nantes (44) - Exhibition for flower shop material
15th FNFF Congress.

Inquiries : FNFF -- 33, rue du Pont Neuf, 75001 Paris (France)

1975 - September 3-6 - Copenhagen (Denmark)
Conference of European Landscape Contractors Association (ELCA)

Inquiries : UNSEPF - 8, rue St Marc, 75002 Paris (France)

1975 - September 6-11 - Budapest (Hungary)
7th International Conference on Rural Electrification, Section IV - Rural Electrification.

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

1975 - September 8-12 - Gembloux (Belgium)
Week study : Agriculture and Plant Hygiene

Information: Semaine d'Etudes de l'Agriculture et Hygiene des Plantes, 2 passage des D6portes, 8-5800 Gembloux, Belgium.

1975 - September 8-13 - Cadarache (France)
VIth annual meeting of ESNA - Working groups : 1-Food irradiation - 2-Radiation induced stimulation effects in plants. 3- Tracer techniques in animal sciences. 4- Radiation analysis. 5- Nuclear techniques in the study of soil-plant-relationships. -6 Applied genesis. 7- Environmental pollution. 8- Nuclear methods infest routine analysis of biological material.. 9- Genetical methods of pest control. 10- Radioisotopes in insect ecology. 11- Nuclear methods in plant physiology.

Informations - R. LAMY - C.E.N. de Cadarache B.P. no 1
13115 - StPauI-lez-Durance (France).

1975 - September 10-18 - London (U.K.)
18e session of International Commission of Lighting (C.I.E.)

Inquiries : Imperial college - London SW 7.2AZ - U.K.

1975 - September 20-30 - Moscow (USSR)
14th International Congress of Refrigeration - Topical aspects of production and utilization of cold in all fields of application (fruits and vegetables).

Information : Organizing Committee - Building 3 - 27 Kalinin Ave. - 121019 Moscow G-19. USSR.

1975 - September 23-26 - Grignon (France)
Permanent formation studies : Mecanism of photosynthesis and plant production.

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

1975 - September 28-October 1 - Maryland (USA)
Symposium on Juvenility in Woody Perennials (ASHS)

Information : Dr R.H. ZIMMERMAN - Beltsville - Maryland (USA)

1975 - September 29-October 1 (1st Session)
October 6-8 (2nd. Session) - Paris (France)
Permanent formation studies : Nutrient solutions for plant cultivation in artificial medium.

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

1975 - October 19-22 - Sofia (Bulgaria)
II. Symposium on plant growth regulators

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

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

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

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

1975 - November 17-20 - West Berlin (FRG)
European Symposium on juvenility in woody perennials

Information : Prof. A. KARNATZ - Inst. f.Nutzpflanzen f.Ohst T.U. Berlin - Fachbereich 15 - D-1000 Berlin Dahlem albr. Thaerweg 3 (FRG)

1975 - November 28-December 1 - GHENT (Belgium)
Xth International. Exhibition of horticultural technics

Inquiries : Foire Internationale de Gand Kortrijksesteenweg 640 - 9000 GHENT (Belgium).

1976 - Quebec (Canada)
International Flora lies of Quebec

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

1976 - February 8-14 - Lima (Peru)
Symposium on Tropical and Subtropical Fruits ; Program Breeding - Minor species - Propagation - Crop physiology - Cultural treatments - Handling and marketing.

Information : R. FRANCIOSI Estacion Experimental Agraria La Molina - Apartado 2791 - Lima (Peru)

1976 - Marsh - Melle (Belgium)
Symposium on Azaleas (ISHS and Eucarpia)

Information : Prof. J. van ONSEM - Inst. of Ornamental Plant Growing, Caritasstraat 21 - Melle 9230 (Belgium).

1976 - April 24-May 4 - Genova (Italy)
Eurofiora 76 - IIIrd International exhibition of Horticulture

Inquiries : Euroflora - Piazzale J.-F.Kennedy 16129, Genova (Italy)

1976 - May - Corsica (France)
Symposium on Problems of Citriculture in Mediterranean Countries (ISHS)

Information : Dr L. BLON0EL - St Rech, Agr. San Giuliano par Mariani-Plage, Corsica (France).

1976 - May - Bucharest (Rumania)

Symposium "Protected cultivation of tomato, pepper, and eggplant."

Organisation : Prof. CEAUSESCU. Project ISHS.

1976 - July 26-30 - Dundee (U.K.)

Symposium on Breeding of Rubus and Ribes and its relation to the RrobIems of mechanical harvesting (ISHS and Eucarpia).

Inquiries : Dr D.L. JENNINGS - Scottish Horticultural Research Inst. Invergowrie - Dundee, Scotland (U.K.)

1976 - July - Hannover (FRG)

Symposium on cultures of Vaccinium Species (ISHS)

Inquiries : Prof. LIEBSTER - Inst. f. Obstbau T.U. Munchen 6050 - Freising Weihenstephan (FRG)

1976 - August 29-September 3 - Rome (Italy)

7..th International Congress on Photobiology

There are 15th Symposia, among them : Photosynthesis, Mutagenic effects of radiation, Light and Development, Photomovement, etc

Information : Dr A. CASTELLANI - CNEN-CSN - Casaccia Casella Postale 2400 - 00100 Rome IS.D. (Italy)

1976 - August - AAS-NLH (Norway) and Alnarp (Sweden)

Symposium on growth and development of potplants and roses (ISHS)

Inquiries Prof. E.STROMME - Dept of Floriculture Agric. College of Norway - N-1432 - Aas-NLH (Norway).

1976 - August 30-September 4 - Lausanne (Switzerland)

IXth International meeting on growth substances

Inquiries : Prof. P.E. PILET - Institut de Biologie et Physiologie vegetales de l'Universit6 - Place de La Riponne - 1005 Lausanne (Switzerland).

1976 - September - Wye College and East Mailing (U.K.)

Symposium on High Density Plantings (ISHS)

Information : Dr J.E. JACKSON - Pomology Section EMU East Mailing nr. Maidstone Kent (U.K.)

1976 - September - Pisa (Italy)

Ornamentals Symposium on Flower Formation of Ornementals (ISHS)

Inquiries : Prof. A. ALPI - Inst. di Ort. e Floricoitura Viale Piagge 23 - 56100 Pisa (Italy)

1976 - October 1-10 - Florence (Italy)

Symposium on Pears (ISHS)

Inquiries Prof. F. SCARAMuZZI - Inst. di Colt. Arboree - Fac. di Agraria - *Piazzale* delle Cascine - Florence (Italy)

1976 - Alexandria (Egypt)

5th African Horticultural Symposium

Information : H.D. TINDALL - Nat. College of Agr. Engineering Silsoe Bedford (U.K.)

1977 - Spring - Antibes (France)
Symposium on Carnations (ISHS)

Inquiries : M.J. GARNAUD - 14 ay. ste Marie, 94 CRETEIL (France)

1977 - May-June - Madrid (Spain)
18th Congress of the International Seed Testing Association (ISTA)

1977 - Ghent (Belgium)
Symposium on Tissue Culture (ISHS)

Inquiries : Prof. BOESMANS Coupure Links 235,
9000 GHENT (Belgium)

1977 - Probably in the Netherlands
Symposium on more profits of the energy on greenhouses (ISHS)

Information : G.H. GERMING - IMAG - Postbox 43, Wageningen (Netherlands).

1978 - August 15-23 - Sydney (Australia)
20th International Horticultural Congress.

Information : Secretary of Congress - G.P.O. Box 475
Sydney N.S.W. 2001 (Australia).

1982 - Hambourg (F.R.G.)
21st International Horticultural ConcrreAA

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

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

P. CHOUARD and N. de BILDERLING