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PHYTOTRONIC NEWSLETTER N°19

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I. EDITORIAL

PHYTOTRONIC NEWSLETTER No. 18 was published with the aid of a special grant from the Directors of the CNRS and this same donation as made it possible for us to send issue No. 19 to you.

Our sincere thanks are addressed to all those who are helping us resolve the material difficulties encountered in putting together a publication of this kind.

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We also would like to thank all those readers who have sent us benevolent financial aid. As always, we request that you address your donations to our intermediary with the endorsement: "Participation aux frais de parution de "Phytotronic Newsletter" and making cheques payable e: "Agent Comptable secondaire du CNRS, 4e circonscription 91190-Gif-sur-Yvette. France".

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The composition of this present issue is not the customary one, due to the publication in appendix four of the chapter "Articles and Scientific Papers", for the following reasons.

As our readers know, the Secretariat Phytotronic had suggested that within the framework of the 20th International Congress of Horticulture in Sydney a Phytotronic Symposium be organized, with the publication of various papers (See No.16, August 1977).

Financial difficulties obliged the French delegation to reduce the number of participants to this Congress. On the other hand, the "Plant Growth Chamber Working Group" of the American Society for Horticultural Science on its own part proposed to the organizers of the Congress the inclusion of a symposium on the Environment in cabinets and growth chambers. The Secretariat Phytotronic as well proposed to the Congress organizers to combine in one single interdisciplinary session two symposiums. The presidency was assumed by Dr. J.C. MacFarlane (USA) with Dr. I.J. Warrington (New Zealand) as Vice-President. The Secretariat Phytotronic, in its role of dispensing information, has accepted to publish the proceedings of the combined session as an Appendix to issue 1°19 of the Phytotronic Newsletter. In order to facilitate the acquisition an above all the classification in libraries of this document, which is very useful to those working on plant environments or users of climatized growth chambers, it was decided to print it in a separate volume. In order to avoid additional delays in publication and to be able to use it for the work of the "Controlled Environment Working Conference" which will take place in Madison (USA) from March 12 to 14, 1979 no French translation was done. It is this collection of the proceedings which is gathered together in the Appendix and presented as it was sent to 44,s by Dr. J.C. MacFarlane who was responsible for the Sydney meeting. We hope that our French language readers will understand why there is no French edition.

This issue, then, consists of:

Annual Reports. A chapter with extracts of two annual reports from Phytotrons, indicating work being done and results obtained. The reports are from 1977 in Canberra (Australia) edited by Dr. I.F. Wardlaw and from 1978 in Palmerston North (New Zealand) edited by Dr. J.P. Kerr.

Articles and Scientific Papers. The chapter is contained in the Appendix to this 19th issue with the proceedings of the Sydney meeting: Growth Chamber Environments. It consists of an Introduction by the President, 9 scientific papers, 3 summaries of papers and Conclusions by the Vice President of the session.

To complete the documents from this session, Dr.Rudd Jones has kindly sent us a text of his conference presented at another session of the Sydney Congress and which bears with the same works, we take up in this issue.

Finally, the Chapter News of Interest, will probably, and as usual, be appreciated by our readers.

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In concluding this editorial, we would like to reiterate our request for all of you to send us scientific or technical documents, articles, news, and papers on fundamental or applied research in plant physiology and horticulture which would interest our readers. We would also appreciate hearing about any meetings or exhibitions being planned. Looking forward to hearing from you, with thanks,

R. Jacques N.de Bilderling

II. 1977. CERES ANNUAL REPORT 1

CSIRO. Division of Plant Industry. Australia

Editors' Note: We received from Dr. I.F. Wardlaw the 1977 Annual Report from which we reprint certain passages:

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CERES has now been operating for 15 years. In this time it has proved extremely valuable in research programs aimed at establishing the basis of plant responses to the environment, including factors such as disease expression, and in providing information on the environmental conditions critical to the growth and development of many plant species.

It has been the policy to encourage the use of CERES, which is a national facility, **14** scientists outside the Division of Plant Industry. In 1977, of the 50 individual users, there were visitors from 3 other CSIRO Divisions, 6 universities, the New South Wales Department of Agriculture and overseas visitors from Japan, England and Thailand. Clearly it is best if visiting research staff can personally carry out their own experiments, but because travel to Canberra from other parts of Australia can be time consuming and expensive, considerable help has been given by CERES staff to visitors in setting up and obtaining data during many of these experiments. For example, help has been given to studies on wing bean from the University of Western Australia, mint species from the University of Queensland and wheat from the Wagga Research Institute.

With a continuously used plant growing facility like CERES, containing a *wide* range of species, disease control is a continuing difficulty. Probably one of the more persistent problems has occurred with red spider (a small mite), as it has been found that many of the effective chemical controls may also damage at least a few of the many plant species grown in CERES, particularly the legumes. However, considerable success has now been achieved, with the co-operation of the Division of Entomology, in establishing a biological control system using as a predator of red spider another mite (Typhlodromus oxidentalis). The success of this predator under glasshouse conditions is due in part to its insensitivity to chemical treatments used to control other diseases.

CERES PROGRAMS

Many programs are undertaken in CERES in a single year and these may or may not be completed in this time. Thus it is not really possible to outline the programs adequately in an annual report of this nature and the comments that follow are included as a guide to the nature of the work that is being undertaken. More detailed descriptions of individual programs can be obtained from other sectional reports and the individuals concerned.

CROP GROWTH AND DEVELOPMENT

Phytotron studies reflect both the continuing interest in yield improvement in the established crops such as wheat and maize, and also a still growing interest in protein and oil crops such as mung bean and sunflower.

Within the cereals attempts are being made to establish the factors controlling grain number in wheat and how grain hardness varies with environmental change. The yield components of rice are also under investigation in a study covering the physiological aspects of rice evolution, while in maize variation in response to photoperiod between strains is being examined.

Legume studies range from the growing of lupins under controlled environmental conditions as an aid to reduce generation times for breeding; through to an examination of how the growth and development of wing bean cultivars interact with environmental changes. One program is aimed at understanding intrastrain variation in symbiotic effectiveness in culture and field populations of Rhizobium trifolii. In this latter example, the problem of nitrogen fixation in legumes is therefore being approached both from the field and in the Phytotron.

Sunflower continues to be an oil cro of considerable interest, but recently studies initiated through the University of Queensland have been established to assess the effect of temperature on oil quality in species of mint from Thailand.

Studies on the establishment and early growth of a range of woody plant species, have utilized a considerable amount of Phytotron space, and include not only timber species such as Eucalypts, pine and teak, but also apples, citrus and the central American desert plant jojoba.

Other crops that have received some attention are elephant grass which is of interest for both forage and in paper manufacture, and vegetable crops such as potatoes and onions.

ECOLOGY

An understanding of the environmental control of the growth and development of native Australian plant species has largely centred on the Eucalypts . In CERES the main interest has been concerned with the adaptation of Eucalypt provenances, studying for example, the relation between altitude and frost resistance. However, the species studied for their adaptation also include Araucaria and several pines. There has also been an interest in factors affecting the germination of species such as Themeda and Emex, and the control of floral development in Caltha.

DISEASE

Although disease studies have, not formed a large part of the total research program undertaken in CERES, variation in susceptibility and disease expression under different environmental conditions is an important factor in the consideration of disease resistance. Earlier studies on blue mould of tobacco provide a good example of this. Recently an examination has been made of factors favoring the buildup of leaf scorch in clover swards, illustrating the effectiveness of low light and high humidity in ,facilitating the spread of this fungus. A study is also underway to determine the best environmental conditions for use when screening rape and mustard for resistance to blackleg disease.

The ability of tobacco mosaic virus (TMV) to infect leaves and become systemic in tobacco plants shows an interaction with the environment and this aspect , with particular reference to temperature, has been examined in CERES. Another factor of interest in relation to virus mobility in the plant has been the possible association with the movement of carbohydrates.

PHYSIOLOGY AND BIOCHEMISTRY

The need to gain an understanding of basic plant processes and how they might be associated with a plants response to environmental changes, continues to provide the incentive for many experiments in CERES. Plant responses to temperature stress possibly involve effects mediated through photosynthesis, growth, or the transport system and an attempt is being made to understand bow these factors operate in the response of sorghum plants to low temperature.

While space has been allocated for the growth of standard plants for studies on the genetic and biochemical control of protein storage and lipid synthesis in several legumes, an interest has now developed in the role of nutrition in regulating the type of storage proteins that are formed. The relation between ploidy and protein in the grain of wheat has also been receiving some attention.

Improved yields might be obtained either by increasing the total dry matter accumulated by a plant, or by more efficiently utilizing the dry matter already available, Experiments in CERES have been designed to examine this question in wheat by increasing photosynthesis through CO_2 enrichment of the air and observing the effect of this on dry matter partitioning within the plant. The need for an understanding of efficiency of use of dry matter in plants is also seen in legumes where estimates are being made of the energy requirements (in terms of carbohydrate losses), needed for the fixation of atmospheric nitrogen by the root nodules.

Hormones play an important role in controlling growth and development but relatively little is known about their formation and action throughout the life of a plant, or how they influence a plants response to the environment. Recent Phytotron work suggests that endogenous hormones, such as abscisic acid may be involved with the effect of water stress on flowering in darnel grass and also with a temporary inhibition of germination during the late stages of wheat grain development. Studies are also being undertaken on the nature of the flowering process using plant species such as darnel grass, morning glory and chenopodium. The Phytotron has also been used to produce uniform plants for studies of the effects exogenous growth substances on the growth of etiolated pea stem segments.

GENETICS AND PLANT BREEDING

Cytoplasmic male sterility is a trait of interest to the wheat breeder, and the way in which this is affected by the environment is being studied in CERES by a group from the University of New England.

Cultivar comparisons are included in many of the experiments already described, to show the way in which plant growth and development are influenced by environmental changes. In this list can be included such crops as wing bean, *rice* and maize and also forage legumes such as lucerne.

PLANT INDEX

ALLIUM	Environmental control of bulbing (B.Steer)
ARAUCARIA	Provenance and species responses to light and temperature (N.Enright, M.Moncur and J.Saunders)
BRASSICA	Screening rape and mustard for resistance to blackleg disease (K.Helms)
CALLITRIS	Temperature and daylength responses (K.Clatyon Greene) Comparative temperature effects (J.Saunders and M.Moncur)
CALTHA	The control of flowering (I.F.Wardlaw)
CHENOPODIUM	Photoperiodic induction of flowering (R.W.King)
CHONDRILLA	Morphological and physiological variation in lines of skeleton weed from the USA (R.H.Groves and L.C.Ericksen)
EMEX	Effects of temperature on germination (M.W.Hagon)
EUCALYPTUS	Temperature effects on cultivars of *E.cloeziana* (J.Turnbull) Photosynthetic temperature optima of *Eucalyptus* populations (R.Slatyer) Comparative growth of *E.melliodora* (K.Clayton Greene) Temperature and light effects on 6 species (M.Moncur and J.Saunders). Frost sensitivity (V.Moura) The effect of air and soil temperature on stump planting (K.R.Shepkerd and P.Sa-ardavut)
GLYCINE	The effect of chemical treatment on yield of soybean (J.N.Phillips and B.M.Rattigan) Fatty acid synthesis in seeds (R.J.Porra)
HELIANTHUS	The effect of photoperiod on floral development in sunflower (M.Moncur and N.Enright)
LUPINUS	Hydrogen evolution in nodulated legumes (A.H.Gibson)
MEDICAGO	Comparative growth rates of lucerne cultivars under a range of temperatures (H.V.Daday)
MENTHA	Temperature effects on soil production of mint accessions from Thailand (E.J.Britten)
NICOTIANA	Factors influencing the movement of T M V in *N.glutinosa* (K.Helms and I.F.Wardlaw)
ORYZA	Physiological aspects of evolution in rice (M.G.Cook and L.T.Evans)
PARTHENIUM	Weed potential (J.D.Williams and R.H.Groves) Environmental effects on latex production by guayula (R.W.Downes)
PENNISETUM	The response of cultivars of elephant grass to temperature (R.Ferraris and M.J.M. Mahony)
PHARBITIS	Identification of the sites of action of GA and cytokinins, as they effect flowering in morning glory (R.W.King and Y.Ogawa)
PHASEOLUS	The effect of temperature on seed quality in beans (G.I.Moss)
PINUS	The effect of temperature on the growth of grafted plants (T.H.Booth) The comparative effects of temperature and light on growth between species (M.Moncur and J.Saunders)

PISUM Response to daylength by peas of differing maturity genotype (Y.Aitken and G.Berry)
Environmental effects on pea seed proteins (A.A.Millerd, J.A.Thomson and H.E.Schroeder)
The effect of nutrition on the development and composition of pea seeds (P.J.Randall)
Lipid synthesis in pea cotyledons (R.J.Porra)
Modulation and hydrogen evolution in peas (A.H.Gibson)
The effect of growth regulators on the growth of etiolated pea stem segments (A.E.Geissler)

PSOPHOCARPUS The response of wing bean cultivars to variations in light, temperature and daylength (G.Eagleton)

PYRUS Environmental effects on the growth and flowering of apple seedlings (R.Williams and M.G.Mullins)

SIMMONDSIA Propagation and the control of flowering of jojoba (J.E.Begg, R.L.Dunstone and I.F.Wardlaw)

SOLANUM The effect of temperature on emergence and tuber initiation in potato (P.J.M.Sale)

SORGHUM Photoperiodic effects during grain ripening (J.Angus and M.Moncur)
Plant responses to low temperature stress (D.Bagnall and I.F.Wardlaw)
The effect of light and soil volume on the water status and osmotic adjustment of stressed plants (N.C.Turner)

TECTONA The effect of light and temperature on seedling development (K.Pinyopusarerk)

THEMEDA Seed dormancy (M.W.Hagon and R.H.Groves)

TRIFOLIUM Symbiotic effectiveness of field isolates of Rhizobium trifolii A.H.Gibson)
The importance of hydrogen evolution in modulated plants (A.H.Gibson)
Studies on clover scorch disease (K.Helms)

TRIGONELLA Developmental control (A.H.G.C.Rijven)

TRITICUM Prediction of phenological development in the field (R.A.Fischer, J.Angus and J.Syme)
The control of grain number in wheat (R.A.Fischer)
Interactions between CO2 concentration and light in crop growth (R.M.Gifford)
The effect of chemical treatments on yield (J.N.Phillips and B.M.Rattigan)
The control of grain development in wheat (R.M.Gifford and P.M. Bremner)
Grain growth in cultured ears (R.W.King and J.ThornIeY)
Abscisic acid and sprounting in cereal grains (R.W.King)
The role of the environment in regulating wheat grain hardness (M.A.Khan)
The effect of the environment on cytoplasmic male sterility in wheat (J.R.McWilliam and NMBamroongrugsa)

VICIA Modulation and hydrogen evolution (A.H.Gibson)

VIGNA Hydrogen evolution and nitrate reductase activity of cowpea (A.H.Gibson)
The comparative physiology of cowpea cultivars (M.Lush)
The control of photosynthate partitioning in cowpea (A.S.Lang)

ZEA Variations in response of maize cultivars from different latitudes and altitudes to changes in daylength and temperature (Y.Aitken)

Those readers who desire more information please write to : Dr Ian F. Wardlaw, Officer in Charge at the following address:

CERES. CSIRO. Division of Plant Industry PO Box 109, Canberra City ACT 2601, Australia.

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III. PLANT PHYSIOLOGY DIVISION D S I R
19 78 REPORT

Editors' Note: We received from Dr. J.P. Kerr, Director, the 1978 Annual Report from which we quote certain passages below.

For more information please write to: Plant Physiology Division, D,S. Private Bag, Palmerston North, New Zealand.

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Physiology is the study of how plants function. Growing plants transform the raw materials of water, carbon dioxide, nitrogen and other inorganic nutrients into proteins, carbohydrates and lipids. Their growth and development is influenced by the environmental variables of light, temperature, water and wind. To learn how plants do this is the primary aim of plant physiology research.

The ability of plants to grow and transform simple raw materials into complex substances suitable to man's needs forms the basis of the agricultural, horticultural and forestry industries. Our task is to see that through our developing knowledge and understanding of plant physiology we contribute to the technology of the primary production systems in these industries.

However, to be effective, physiologists must get to know and become involved with plant breeders, agronomists, horticulturalists and foresters, pathologists, soil physicists and chemists, extension specialists, farmers, growers and others. This report outlining our current research program is one way in which Plant Physiology Division is moving to develop that rapport.

LOCATION

Plant Physiology Division is located at Palmerston North (pop.55,000) adjacent to Grasslands and Applied Biochemistry Divisions DSIR; the New Zealand Dairy Research Institute and Massey University. Several other DSIR Divisions have substations located at Palmerston North. These include Crop Research, Plant Diseases, Entomology, Applied Mathematics, Soil Bureau and Physics and Engineering Laboratory. The regional Soil and Field Research Station, MAY and the Plant Materials Centre, MWD are nearby.

The Division has well equipped laboratories for biochemistry, physiology, tissue culture and genetic engineering research. Controlled environment facilities (described elsewhere) are available, and biohazard containment facilities (Category 2 level-Williams report) are being constructed for genetic engineering research. Library, electron microscopy and computing facilities are available on campus.

Land available for field research includes the Tiritea Research Area, comprising 20 ha of Tokomaru silt loam which is irrigated, mole-and tile drained. An additional 4 ha has been made available by Massey University on a free draining recent alluvial soil. Manawatu fine sandy loam. A mobile caravan equipped with a datalogging *system* and mini-computer is available for agricultural physics research. A range of agricultural machinery is available far agronomy research.

HISTORY

Plant Physiology Division was established in 1962 with Dr K.J. Mitchell as Director. The initial staff of 12 has now grown to 58. Much early effort was directed to the design and construction of the Climate Laboratory under the Directorship of Dr K.J. Mitchell. The Laboratory was opened in 1970 and is run as a national research facility available to scientists throughout the country. Dr Mitchell also played an active role in promoting interest in the potential of using conserved forage crops as an alternative to pasture for feeding ruminants. In 1974 he was appointed Director, Research and Surveys, Water and Soils Division, Ministry of Works and Development and Dr J.P. Kerr was appointed the Director of Plant Physiology Division.

RESEARCH PROJECTS

I.CLIMATE LABORATORY

The Climate Laboratory was opened in 1970 and is operated as a research facility available to scientists from DSIR, Ministry of Agriculture and Fisheries, Forest Service, Universities, and the private sector throughout New Zealand. The Laboratory cost $ 800.000 to build and has been operating at 90% capacity since 1972. Projects proposed by scientists are reviewed by the Climate Room Allocation Committee who allocate room space. Normally there is at least a 6 month queue.

There are 24 walk-in controlled environment rooms with the following specifications:

Temperature: 0 to 50 C (+ 0.5C) special frost rooms operate down to -20C.

Humidity : 10 to 95% RH (+ 5%)

Day/night changeover: The changeover rates for temperature and humidity can be programd to occur over 2,3,4, 6, 8 hour periods.

Carbon dioxide: 300 to 1000ppm or monitored

Light intensity: Up to 400 W/m2 PAR (photosynthetically active radiation) (equiv. to 2000 µE/m2/sec PAR) Normal intensity: 160 to 180 W/m2 PAR

Daylength : 5 min to 24 hours

Spectrum: The spectrum is normally balanced to simulate daylight but may be adjusted using different lamp combinations

Nutrition; Automated application through a microtube system to individual plant containers : 4600 container capacity

Growing media: Soil (sterilised or unsterilised) peat, sand, vermiculite, pumice are used alone or in mixtures.

Further technical details are given in the Climate Laboratory Operating Manual and the Climate Laboratory Guide which are available on request. A Climate Laboratory Newsletter/describing recent experiments and publications, and containing feature articles on controlled environment techniques and research is published regularly. This *is* available on request.

More than 160 projects have been completed since the Climate Laboratory was opened. These have been described in some 60 scientific papers and 30 reports and conference presentations. Typical projects include: studies of simulated frosting of Eucalyptus spp. and Pinus radiata planting stock; temperature and atmospheric humidity effects on selected tropical and temperate grasses: thermotherapy for virus elimination from ornamental plants: and low temperature effects on pollen viability in sorghums. Work has involved studies of plant responses to soil nutrients , pests (e.g. armyworm caterpillar, sitona weevil) and diseases (e.g needle blight and terminal crook on radiata pine, black scurf on potatoes, rust on poplars).

To date the species grown in the rooms include: white, red, subterranean and Alsike clovers, and Lotus spp. Pinus radiata ,Douglas fir, poplar and Eucalpytus spp.ryegrass spp., paspalum, prairie grass, Yorkshire fog, and lucerne, wheat, maize, oats and sorghum : potato, tomato, pea, lettuce, and Kiwi fruit; tobacco, safflower and soybean.

Facilities are being built for studying the effects of air pollutants such as sulphur dioxide on plant growth.

BIOLOGICAL SERVICE. Experiments in the rooms are overseen by the biological services team of six who collaborate with-the visiting scientists, by setting up the experiments and undertaking biological measurements and biochemical analyses at their request. A report containing experimental methods and results is prepared at the end of each project.

Apart from management of these experiments, staff are involved in experiments designed to test and improve the biological performance of the controlled environment rooms.

1.1. Comparisons of plant growth under various lamp combinations of similar photon flux densities (I.J. Warrington, L.M. Green)

1.2.Plant growth and development under high irradiance levels. I.J. Warrington, Edge

1.3.The influence of preconditionning temperatures and repeated frost regimes on the survival of Pinus radiata. L.M. Green

1.4.A study of the leaf and reproductive development of maize: responses to temperature. I.J. Warrington, C.A. Stewart, E.T. Kanemasu.

1.5.Growth of wheat at low temperatures. F.L. Milthorpe, C.A.S tewart

1.6.Vernalization and photoperiod responses in Australian and New Zealand wheat cultivars. A.T. Pugsley, E.A. Edge, I.J. Warrington

1.7.Effect of temperature on final seed yield and oil content of safflower (Carthainuf tinctorius) L. Green, I.J. Warrington, C.R. Slack.

1.8.Effects of routine handling on plant growth. M.F. Beardsell

1.9.Daylength temperature effects on time to flowering of Pigeonpea (Catanus cajan) H.G. bic Pherson, I.J .Warrington, C.A. Stewart, J.M. Green

TECHNICAL SERVICE: The technical systems are serviced by seven staff with electronics, lighting, engineering, refrigeration and instrumentation skills. They have prime responsibility for the successful technical operation of the Climate Laboratory but with additional responsibilities of streamlining and updating the technical performance of the climate rooms.

1.10. Modification of frost rooms to reach -20°C. J.B. Lloyd R.W. Robotham, M.L.Tarr,B.R.Tynan

1.11. Development of a plant tissue culture cabinet. R.W.Robotham, J.B.Lloyd, V.L.Johnson, B.R.Tynan

1.12. A nutrient injection system for individual plant trolleys. B.R.Tynan

1.13. Updated electronic system for control of day-night changeover rates. G.Bristow, R.W.Robotham

1.14. Cabinet for air pollutant studies. T.W. Spriggs, J. Gordon

2.TISSUE CULTURE AND GENETIC ENGINEERING

When pieces of tissue are excised from intact plants and cultured under sterile conditions in a balanced nutrient medium, they can be induced to resume cell division. Such tissue cultures can be grown either as relatively undifferentiated lumps known as callus, or a suspension cultures of single cells and cell clumps. Exposing callus cultures to the right balance of plant hormones and nutrients induces the formation of roots, shoots, and eventually whole plants.

Tissue culture techniques are now used in many areas of basic research, however they have also attracted considerable attention because of three major areas of potential commercial application:

1. Mass clonal propagation of vegetables, ornamental plants and forest trees
2. Virus curing and the maintenance of high health plant stocks.
3.'Cenetic engineering/or the construction of plants with new combinations of genes by methods that overcome some of the barriers to inter species breeding.

A symposium on plant tissue culture held in Palmerston North in February 1975 led to the TCGE group of Plant Physiology Division taking the major responsability for plant tissue culture and genetic engineering research within the DSIR. The group aims to maintain expertise in a broad range of techniques, and to provide a focal .point for both basic and mission oriented research with plant species of importance to New Zealand. In pursuit of these aims a symposium with several Australian professional and commercial visitors was held in Palmerston North in 1977, and two workshops for commercial plant propagators have been organized so far.

Joint projects are underway in collaboration with staff of the Ministry of Works and Development's Plant Materials Centre, Massey University's Nursery Research Centre, and the Ministry of Agriculture and Fisheries' Horticultural Research Centre at Levin. In addition, several commercial plant propagators are being assisted with specific problems.

The genetic engineering interests of the TCGE group have been concentrated on the possibility of creating new nitrogen fixing symbioses between plants and micro organisms. A major part of our effort has been in exploring some of the basic features of important naturally occurring symbioses with special attention being devoted to the Rhizoisium legume association because of its economic importance.

2.I.Tissue culture propagation of ornamental plants D.Cohen

2.2.Heat therapy and meristem tip culture of some virus infected plants. D.Cohen, K.Milne, C.R.Slack

2.3.Micropropagation of strawberries. W.D.Sutton, D.Elliott, H.C.M.Whitehead

2.4.Micropropagation of poplars for soil conservation K.L.Giles , H.C.M.Whitehead

2.5.0rgan culture of detached lupin root nodules W.D.Sutton, N.Jepsen

2.6.Protein synthesis capacity of Rhizobium bacteroids B.D.Sham4 W.D.Sutton

2.7.Viability of Rhizobium bacteroids and bacteria W.D.Sutton , A.Paterson

2.8.Transfer of nitrogen fixing ability of Azotobacter vinelandii into sphetoplasts of mycorrhizal fungi-KA-Gun, HA.M lakitehead.

2.9.Selection of mutant clones of Azotobacter. B.Terzaghi, W.D.Sutton.

3. PLANT PHYSIOLOGY WATER STRESS

Droughts cause large reductions in yields of crops and pastures but the physiological mechanisms responsible for decreased yields are poorly understood. Research on water stressed plants is aimed at better understanding the physiological basis for these yield reductions. This knowledge will help in improving principles for the management of plants under dryland and irrigated situations and in choosing criteria to be used in breeding plants better adapted to dry conditions.

3.1.Effect if water stress on leaf growth in prairie grass. H.G.McPherson, A.C.P. Chu G.Halligan

3.2.A comparison of the response of leaf growth to water stress and temperature in Nui and Ruanui ryegrass. A.C.P.Chu , H.G. McPherson, P.I.Rollinion.

3.3.Water use adaptation. H.G.McPherson, A.C.P.Chu

3.4.Effect of duration of water stress on leaf growth on maize P.W.Gandar, H.G. McPherson, M.F.Beardsell

3.5.Effects of water stress on apple trees in an orchard. M.F.Beardsell, E.W.Hewett

3.6.Stomatal behaviour in two clones of Pinus radiata Known to differ in transpiration and survival rates K.J.Bennett, D.A.Rook

3.7.Cell division and expansion in the growth of grass leaves. P.W.Gandar, K.L.Giles

3.8.Development of a fast response wickless psychrometer H.G.McPherson, K.J.Bennett, T.W.Spriggs, J.A.Gordon

3.9.A method for the measurement of rates of leaf extension in grasses. H.G.McPherson, P.L.Rollinson, J.A.Gordon

3.10.The effect of temperature adaptation on wheat photosynthesis.K.J.Bennett, F.L.Milthorpe

4.PLANT BIOCHEMISTRY

LIPID BIOSYNTHESIS. The degree of unsaturation of the fatty acids in seed oils largely controls the physical properties of the oils and there is increasing worldwide interest in obtaining oils that have properties suitable for use in foods and industrial processes.

The extent of fatty acid unsaturation in the lipids of plant membranes similarly influences the physical properties of these membranes, and as a consequence is related to the temperature tolerance of plants.

In view of the increasing interest in New Zealand in the establishment of oil crop industries, and also in obtaining maize varieties with improved ability to grow at low temperature, studies are being made of the mechanisms of fatty acid desaturation in plants. Concurrent investigations into the growth of potentially useful oil crops, and of the oil content and composition of these crops, are being made.

4.l.The biosynthesis of polyunsaturated fatty acids and glycerolipid metabolism in plants P.G.Roughan, C.R.Slack, A.Balasingham, R.Holland, J.Browse

4.2.Lipid biosynthesis in leaves and oil seeds, C.R.Slack, P.G.Roughan, R.Holland, A.Balasingham, J.Browse

4.3.011 content and composition of safflower hybrids. C.R.Slack, A.Balasingham, J.M.Mc Ewan, K.A.Armstrong

4.4.The influence of pretreatment conditions on biochemical analysis of plant material R.M.Haslemore, P.G.Roughan, I.J.Warrington

4.5.Prediction of in vivo digestibilities of forage samples using incubation with fungal cellulases. P.G.Rougham , R.Holland.

PHOTORESPIRATION. Oxygen inhibits photosynthetic CO2 uptake and consequently plant growth. Rates of CO2 uptake at ambient concentrations are increased by up to 50% when oxygen is removed. The oxygen inhibition of photosynthesis has two components: firstly, oxygen competes with CO2 on the active site of the enzyme ribulose bisphosphate carboxylase (RuBPCase) ,directly reducing CO2 fixation; secondly, oxygen reacts on the site to form phosphoglycolic acid , which is further metabolised to release CO2. About one third of the increase in photosynthesis on removal of oxygen can be attributed to decreased photorespiration, and two thirds to avoidance of direct oxygen-inhibition of photosynthesis.

A group of sub-tropical plants called C4 plants (e.g maize, sorghum, and paspalum) , do not have oxygen-sensitive photosynthesis. Atmospheric CO2 is initially fixed by phosphenolpyruvate into an intermediate; which is transported to the site of RuBPCase and decarboxylated, driving the CO2 concentration up to a point at which oxygen cannot successfully compete. This allows higher rates of net photosynthesis and consequently higher growth rates, than in species lacking these adaptations.

The removal of oyxgen sensitivity of photosynthesis could lead to a 50% (or greater) increase in dry matter production. The long-range goal of this research is the development of plants which do not photorespire and are not subject to oxygen inhibition; and therefore have increased dry matter production.

4.6.Activation and catalysis of ribulose bisphosphate carboxylase and oxygenase from soybean . W.A.Laing, J.T.Christeller

4.7.0O2 fixation in lupin root nodules J.T.Christeller, W.A.Laing, W.D.Sutton

4.8.Photoautotrophic growth by suspension cell cultures. W.A.Laing, J.T.Christeller, C.Parrish, K.L.Giles.

5.GRAIN CROPS

The genetic yield potential of grain crops may be increased further by fitting cultivars more closely to their environment. The Division's maize program, aimed at identifying cool tolerance characteristiw in populations is based on this concept. This illustrates one way in which physiological inputs can potentially assist a plant breeding program. Physiological research such as the study of disorders in seed vigour of peas can assist in isolating environmental factors which affect grain quality and yield.

5.1.Cool tolerance in maize, H.A.Eagles, T.D.Lewis, A.K.Hardacre, R.Bansal

5.2.Protein content of oat varieties. H.A.Eagles, R.M.Haslemore, C.A.Stewart

5.3.Influence of plant morphology and dwarfing genes on the yield of winter wheat. I.R.Brooking, E.J.M.Kirby

5.4. Examination of physiological disorders in seed vigor in peas.MIAWichnilSam140. 5.5.
A simple grain drying cupboard M.L.Tarr, J.A.S.Johson

6.FORAGE CROP DEVELOPMENT

Animal production systems in New Zealand are primarily based on pasture but farmers have to establish feed reserves which can be used when the climate seasonally swings against pasture production. These reserves are particularly necessary at high levels of production and when stock numbers are being increased. In this situation high yielding forage crops suitable for producing, food quality silage are particularly useful.

Double cropping systems based on maize as a warm season crop are being examined. Both the small grain cereals and several annual legumes of Mediterranean origin are potential cool season crops. Total annual yields from such a system exceed 35.000 kg/DM/ha on research plots and paddock yields around 30.000 kg/DM/ha can be expected. Fitting two crops into one year means that sowing and harvest times are critical. Therefore minimum tillage and direct drilling methods of crop establishment are being examined and harvesting dates must be selected which optimize nutritive quality and crop yield.

6.1.Forage yield, regrowth and nutritive quality of annual cool season legumes K.A. Hughes, A.O. Taylor

6.2.Environmental effects on flowering of annual cool season legumes J.M.de Ruiter, A.O. Taylor

6.3.Resistance of Medicago species and lines to blue green aphid and sitona weevil M.J. Esson, M.J. Mathison, A.O. Taylor, K.A. Hughes

6.4.Forage production by Medicazo truncatula and Ornithropus sativus as affected by soil nutrient supply and lime pelleting of seed J.M.de Ruiter, A.O. Taylor

6.5.Nitrogen fixation by cool season forage legumes J.M.de Ruiter

6.6.Cool season forage crop production trials A.O. Taylor, S.J.Mc Cormick, J.P.Kerr, C.T. Mortlock, R.C. Stephen, D.S.C. Wright, P.H. Menalda, B.J. Hunt

6.7. Yield improvement of oats by backcrossing H.A. Eagles , T.D .Lewis

6.8.Field wilting of cool season forages for silage conservation A.O. Taylor, R. Thaine, K.A. Hughes, B.E. Clothier

6.9.Direct drilling of maize with a modified pasture undersower C.G.Tunnicliffe

6.10.Growth of pasture legumes in association with the subtropical grasses Setaria sphacelata and Cynodon dactylon in Northland. L.J.Davies, B.J.Hunt

6.11.Agronomic performance of selected summer producing grasses in associatim with temperate pasture species in Northland. L.J.Davies, A.O.Taylor, B.J.Hunt

6.12. Effect of cutting height and of cover crops on the winter survival of subtropical grasses at Palmerston North. L.J.Davies, K.G.Mc Naughton

Form systems

6.13.Testing of conserved forage systems on Northland dairy farms A.O.Taylor, N.D.Hart, H.Harris

6.14.Use of conserved feed supplies to combat summer drought problems on Lands Department block in Northland .A.O.Taylor, B.S.Charman

6.15.Spreading the seasonal pattern of cattle Kill A.O.Taylor, S.J.Clakson, R.F.Brown, A.F.Mc Rae

6.16.Intensive double cropping systems for a beef feedlot. A.O.Taylor, R.F.Brown

7.AGRICULTURAL PHYSICS

Many physical factors influence the growth and development of plants. Pasture and crop water requirements must be met and the influence of weather, soil and plant factors on water use must be known in order to optimise yields. Data on soil Water movement and storage within the root zone and drainage losses from that zone provide an understanding of the water supply to the growing crop. Finding answers to these questions requires a significant input of a physical measurement and theoretical models.

Physics has found additional application in field studies of wilting silage and hay drying; energy inputs into agricultural systems; measurement of carbon dioxide fluxes above the crop; and the measurement of temperatures around frost susceptible crops.

7.1.Energy analysis of dryland and irrigated farm systems T.W.Spriggs

7.2.Microclimate modifications using a mobile wind barrier K.G.McNaughton, A.Green

7.3.Modelling evapotranspiration of a maize crop J.P.Kerr, B.E.Clothier, P.H.Menalda, P.L.Rollinson

7.4.Water balance of a winter forage oats crops B.E.Clothier, D.R.Scotter, J.P.Kerr

7.5.Moisture flow and water content profiles in layered Manawatd fine sandy loam. B.E.Clothier, D.R.Scotter, J.P.Kerr

7.6.Nitrogen and water balances of a forage cropping system P.G.Regg, P.W.Gandar, A.N.Mac Gregor, P.H.Menalda, B.E.Clothier,S.A. **Roughan**

7.7.Physics of field wilting of sillage and hay drying B.E.Clothier, P.H.Menalda

7.8.Estimation of net photosynthesis of a paspalum pasture J.P.Kerr, J.S.Talbot, B.E.Clothier

7.9.Development of a real time Basic data-logging system J.S.Talbot

OTHER ACTIVITIES

Plant tissue culture symposium

The second New Zealand Plant Tissue Culture Meeting was held under the auspices of the International Association for Plant Tissue Culture at Plant Physiology Division in February 1977. Genetic engineering, nitrogen fixation and the application of tissue culture to horticultural practice was discussed. Overseas visitors included Prof.M. Mullins, Sydney University, Dr.P.Gresshoff, Australian National University, Canberra;

and Mr H.M.van der Staay who described his own commercial operation for tissue culture propagation of ferns. The 3rd symposium is planned for 1979.

Soil and plant water symposium

Approximately every 3 years a symposium on soil and plant water has been hosted by Plant Physiology Division. In 1976 54 scientists from DSIR, Ministry of Agriculture and Fisheries, Ministry of Works and Development, Forest Research Institute, Universities and the Meteorological Service attended the Symposium. Twenty seven papers were presented at the sessions dealing with soil water, plant water, irrigation, catchment and hydrology and water harvesting, evapotranspiration and crop water use. The Proceedings of the 3rd symposium have been published as DSIR Information Series Bulletin n°126, 1977.

Climate room allocation committee

This committee is responsible to the Director General, DSIR and its prime function is to allocate the Climate Room space to the users. Current membership comprises Dr J .P.Kerr (Chairman), Mr I.J.Warrington (Secretary) together with the following representatives of the four main user groups: Dr E.Wright (DSIR), Mr I.J.Inkster (MAP), Dr R.Cameron (FRI) and Dr K.Milne (Universities) .The committee meets at least once each year.

Controlled environment cabinet workshop

In June 1977 a workshop on Controlled Environment Cabinets was held at Plant Physiology Division. Papers on various aspects of cabinet technology were presented by staff to 16 participants drawn from the Universities and research establishments throughout New Zealand. The workshop was centered around the commercially produced Temperzone cabinet which has its origins in the cabinets designed and constructed at the Division during the 1970's. Papers were published in the Technical Report n°6.

Tissue culture for propagation of poplars

Mr.I.J.Warrington was asked by the Soil Conservation and Rivers Control Council in 1976 to chair a vvotKing party on Tissue culture for propagation of poplars and other woody species with potential for erosion control'. The committee comprised Dr K.L. Giles (PPD), Mr J.T.Hogg (Rangitikei Wanganui Catchment Board), Mr M.King (Wairarapa Catchment Board), Mr C.W.S. van Kraayenoord (Plant Materials Centre, MWD) and Mr M.Richards (Massey University) . The final report was presented in early 1977.

The Council subsequently approved the establishment of a pilot tissue culture unit at the Aokauter Science Centre MWD. This will have an initial capacity of 200 000 plantlets per annum.

Plant Physiology Division will be continuing in research and development work on tissue culture propagation of other woody species with potential conservation use.

University research contracts

Two research contracts have been established with the Universities:

a; Nitrogen cycling in cropping rotations Department of Soil Science, Massey University

The aim is to improve understanding of nitrogen cycling in cropping systems in order to use nitrogen fertilizers more efficiently. Two cereal crops per year are being grown on a mole tile drained Tokomaru silt loam. The N cycling processes of plant uptake, leaching, mineralization and immobilization are being monitored in order to prepare a balance sheet model. Losses of N in drainage water from unfertilized plots approximated 100-150 kg N/ha over the 1977 winter.

b. Effects of water stress on the vegetative production of some pasture and forage plants
Agronomy Department, Massey University

The aim of this project is to determine the sensitivity to water deficits of selected pasture species and to determine the effect of longer term inhibition of leaf growth on yield. Currently prairie grass, Ruanui and Nui ryegrasses are being studied.

TECHNICAL REPORTS

1.Talbot J.S. Microclimate computing system June 1972. Tech. Report n°1 90 pp.

2.Rowley J.A., C.G.Tunnicliffe and A.O.Taylor. A temperature gradient Om and an electrical conductivity assay for cold tolerance studies. August 1975, Tech.Report n°2 12 pp and tables.

3.Robotham R.W., T.Dixon, B.Pickett, V.Johnson, J.Lloyd, B.Tynan, M.Tarr. Report of tests carried out on Temperzone controlled environment cabinet by Plant Physiology Division DSIR, April, 1976. Tech.Report n°3, 30 pp.

4.Taylor A.O., S.J.McCormick, J.P.Kerr, C.T.Mortlock, R.C.Stephen, D.S.C.Wright.Cool season forage crop production trials.Biological and environmental data. November 1975 Tech.Report n°4, 128 pp.

5.Hardacre, A.K. and B.T.Pickett. An inexpensive semi automatic device for watering plant containers to preset weights. July 1976 Tech.Report n°5, 5 pp and figures.

6.Wratt G.S.(Editor) .Proceedings of a workshop run by Plant Physiology Division, DSIR, on controlled environment cabinets. June 1977. Tech.Report n°6, 62 pp.

SERIAL PUBLICATIONS

1.Climate Laboratory Newsletter. Published annually. Editor: I.J.Warrington

2.WISPAS a newsletter about water in the soil - plant - atmosphere system. March, July, November each year. Editors: B.E.Clothier, P.L.Rollinson.

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IV. ENVIRONMENTAL CONTROL IN VEGETABLE CROP MANAGEMENT

Dr.D. Rudd Jones, Glasshouse Crops Research Institute,
Littlehampton U.K.

Protected cropping in greenhouses has been practiced commercially in the North temperate regions of Europe and North America since the 1870's. It has been directed at the production of fresh salad fruit and vegetable crops outside the natural season of production. The use of environmental control enables such production to take place and allows for cropping on a year round basis. It also enables the quality of produce to be improved and provides for consistent and high yields. Traditional areas of production have been between 35° and 55° North but the widespread introduction of plastic film cladding has resulted in the expansion of protected cropping to more Southerly latitudes such as the littoral zones of the Mediterranean and the Southern States of the USA, and even further South.

The much cheaper protection afforded by plastic film means that it can now be used for a wider range of crops for the improvement of both yield and quality. Incidentally, the introduction of plastic has strengthened the export potential of countries such as Israel, Kenya and Mexico, to name but three examples in the supply of fresh produce to North temperate countries.

More recently too, the rising standards of living of the Middle East countries associated with oil production have provided a major stimulus to an entirely new concept of protected cropping in arid zones where cooling systems are required to keep the temperature down, and this constitutes a new type of horticultural production described as "controlled environment agriculture".

In commercial practice full account has of course to be taken of the economics of crop production in the controlled environment of a greenhouse; the capital and running costs are high and become higher the more sophisticated the controls. One environmental factor only - solar radiation - is beyond the control of man. Nevertheless the yields can be spectacular. A full season's tomato crop in heated glass in the UK can yield as much ase 375×10^3 kg ha^-1 (150 tons a^{-1}) and cucumbers as much as 630×10^1 kg ha^{-1} (250 tons a^{-1}).

The control of the environment in which the crop is growing and to which it responds can be looked at conveniently as two distinct parts: -

i) the aerial environment to which the above ground parts of the plant) the stems and leaves - are exposed, and

ii) the root environment to which the below ground, non green, parts of the root system are exposed.

TEE AERIAL ENVIRONMENT

The factors that need to be controlled in the aerial environment are light, temperature, atmospheric composition (especially carbon dioxide) and relative humidity.

Light: The amount of solar radiation available for crop growth in a particular area is dependent on both daylength and intensity. It cannot be increased but there are measures that can be taken to ensure that the maximum proportion of incident radiation reaches the crop. Despite precise environmental control greenhouse crops seldom achieve more than one per cent efficiency in using light energy for the production of the energy rich plant material that is harvested (Warren Wilson 1972). 30% of the daylight available is lost through reflection or absorption by the greenhouse (it can be more with plastic film). Latitude determines season and daylength. Days in the Northern hemisphere are longer and warmer in the Summer than in the Winter, and a combination of short days and cloudy conditions may prove limiting for plant growth in the Northern Winter, quite apart from the economic considerations of providing adequate temperatures for crop growth. An oceanic climate, such as that of the UK at 50-55°N, can also prove more limiting in terms of protected cropping during the Summer than a Continental climate at a more Northerly latitude, as, for example, Alaska (60-65°N).

During the past 25 years there has been considerable development in the design and construction of greenhouses, the main objective being to improve light transmission during the Winter and Spring months. Prior to 1960 the majority of greenhouses were built in multi span blocks orientated North-South. Such greenhouses had a mean overall transmission of light in mid Winter rarely exceeding 40%, and in many cases as low as 35%. Modern greenhouses achieve 70% light transmission, and it can be inferred as an approximation that a one per cent increase in transmission gives a potential increase in yield of one per cent (Sheard 1972).

The marked improvements that have taken place arise from the development of materials and structural design, from studies of the roof geometry and from changing the orientation from North-South to East-West. Timber houses have been replaced by steel and aluminium to give structural members of greater strength and smaller size. This in turn allows for larger panes of glass with smaller and fewer glazing bars. The re-orientation from North-South to East-West has meant that light transmission in December can be increased from less than 50% to 70% in a single span house.

Because of this improved light transmission there had been a trend to increasingly wider span houses of up to 26 m. The fuel crisis that came at the end of 1973 dramatically halted this trend because of the much greater cost of heating such houses. The most popular greenhouses now in Western Europe are probably the multi span "Venlo" blocks with a span width of 3 m, and in the UK the single span 6.7 m greenhouse.

Another important aspect of light transmission relates to the need to keep the glass clean. Even in areas not subject to pollution, reduction in light transmission can be of the order of 10% and is commonly as high as 25%.

All aspects of light so far considered relate to solar radiation, and it is a fact that no artificial lighting can economically replace natural radiation in the growing crop although various enterprises have been set up where crops have been raised almost entirely under artificial light. The main use of artificial light has, however, been during the propagation stages of tomato, cucumber and lettuce crops. Either bench lighting units or growing rooms specifically built for propagation are being used with ligh levels from a minimum of 2000 lx to as much as 10.000 lx. These light levels are normally used for a period of about two to three weeks for tomatoes. The light sources are 40w fluorescent tubes for the low illuminance, supplementary lighting, to 400 w high pressure mercury fluorescent lamps with internal reflectors (HLRG) or 180w low pressure sodium (SOX), or 400w high pressure sodium lamps (SON/T) far the higher light levels used in growing rooms. 400w high pressure mercury fluorescent lamps with internal reflectors (MBFR/U) are also being used.

Temperature

The optimal temperature requirements for the growing and developing stages of the crop and the requirements for the fruiting stages can be distinguished for crops such as tomatoes or cucumbers. Generally speaking the cucumber has a higher temperature requirement than the tomato. By contrast the lettuce crop, with a vegetative harvest more tolerant of lower temperatures, can be grown as a heated crop in Winter or in cold houses in the Spring, and different cultivars have been bred for these different temperature regimes.

The development of highly efficient heating systems has been essential to the more precise control of temperature (Sheard 1978). Since the war there has been a switch from solid fuel to oil, which started to become competitive from the mid 1950's and progressively took over as the main fuel in the UK during the '60s with the introduction of modern packaged boilers. At the same time simple ON/OFF controllers gave way to proportional controllers so that both heat production and heat distribution in the greenhouse could be accurately controlled. Warm air heaters were also introduced in the '50s, their main advantage being the low capital cost of installation. Oil is the main fuel in the UK whereas in Holland natural gas has been the most widely used fuel although there is now some move back to oil with a reduction in natural gas supplies.

Thermal efficiency of modern boilers is a high as 85%, but there are of course enormous losses of heat from greenhouses, and heat conservation is a major objective in keeping down the costs of production. Heat is lost by convection and radiation through the superstructure (80%), by air leakage (12%), and by conduction through the soil (8%). Wind is a major factor in contributing to heat loss, and the benefit of wind breaks has been amply demonstrated. The scope for insulation in a greenhouse is obviously limited but an inflated plastic roof house has been developed by the National Institute for Agricultural Engineering in the UK which can reduce heat loss by as much as 387.. However, it also reduces light transmission by 14% under dry conditions, and this figure can be much higher with condensation. A system of thermal screens has been devised and developed at the same Institute which can be drawn above the crop at night. Heat loss, using these screens, has been reduced by 35% with a saving in the annual fuel bill of some 20%. Other reflective materials now being examined can reduce heat *losses* by as much as 55%, but there can be undesirable side effects from the consequent raising of the humidity and the spread of disease (Winspear, in press).

Despite the high cost of heating of greenhouses where nearly half the total costs of production or two thirds of the direct costs are attributable to fuel and labour in approximately equal proportions, it is worth noting that solar radiation provides a major component in the heat balance of a greenhouse during daylight. Thus, in an early heated tomato crop in the UK, solar radiation provides 20% of the day time energy requirements in January, 26% in February, and 52% in March (Sheard 1978).

Where we are concerned with cooling rather than with heating, it appears that the energy requirements are roughly comparable. The plants themselves can account for over half the solar radiation received by the evaporative cooling process of transpiration. Fan and pad cooling systems and mist sprays are methods of evaporating cooling used in commercial production systems.

In the UK , the major attention with regard to temperature control has been directed towards early and main crop heated tomatoes. In 1971 the Agricultural Development and Advisory Service of the Ministry of Agriculture, Fisheries and Food first published a short term leaflet n° 38 on this subject which has come to be known as the Tomato Blue print (Anon 1971) . The leaflet is based on a large number of experiments carried out at Experimental Horticulture Stations, at the Glasshouse Crops Research Institute, and in monitoring of production at growers' holdings. It was reviewed in 1974 and revised in 1976, and now provides a very precise specification for achieving high yields of glasshouse tomatoes. We may expect that it will be further modified as a result of experiments now in progress, especially with regard to night temperature control. The blueprint is based on five growth stages of the tomato (table 1).

Ina typical full season crop grown in Southern England at about 50°N, *seed* will be sown in the first two weeks of November. Pricking out (stage 0) will follow about seven days later (stage 1) and the plants placed in the greenhouse early in January in pots. Some growers plant immediately but because of low soil temperatures other growers will defer planting until the first truss is set (stage 2) . Stage 3 continues from planting till about two weeks after the start of picking, which normally commences about the third week in March. Stage 4 continues to the end of cropping, and normallyCO_2 enrichment will cease at the end of April once the ventilators are frequently opened during the daytime as a consequence of solar heat gain.

TABLE CT.. Blueprint for the production of early and main crop heated tomatoes

Degrees C (°F)

	NIGHT	DAY		
Stage of Growth	Minimum .Temperatures	Minimum Temperature	Ventilation Temperature	
0.Sowing to pricking off	20 (68°F)	20 (68°F)	24 (75°F)	
1.Pricking out to truss buds just visible in head of plant	15 (60°F)	20 (68°F)	24 (75°F)	
2.Visible truss to first flower opening. Planting before late February	15 (60°F)	18 (64°F)	24 (75°F)	
Planting after late February	15 (60°F)	20 (68°F)	24 (75°F)	
			With CO_2	Without CO2
3.Planting till about , 2 weeks after start of picking	13-16 (56-62°F)	20 (68°F)	26 (80°F)	24 (75°F)
4.To end of cropping	13-16 (56-62°F)	18 (64°F)	21 (70°F)	21 (70°F)

Whilst the establishment of optimal temperature regimes has for many years been a major objective of research into production techniques for glasshouse crops, and especially for tomatoes, it is only within the past 10 years that attempts have been made to link temperature control to incoming solar radiation. Nevertheless it had long been apparent that in poor light conditions high temperatures induced tall, weak plants, which failed to flower and fruit normally. By contrast, when light conditions are reasonably good, high temperatures hasten plant development without adverse effects on flower and fruit production (Slack and Calvert 1972). Fundamental studies on photosynthesis by Gaastra (1959, 1963) showed that although the temperature response curve of tomatoes remains fairly flat over the range of 20-30°C at ambient CO2 levels (330 vpm) , there can be an increase in photosynthesis of about 30% over the same temperature range when the environment is enriched with CO2 to 1300 vpm. Subsequently Hand and Bowman (1969) devised some apparatus which led to the development of the NIAE light modulated controller by Bowman and Weaving (1970). Essentially this controller enables temperature to be modulated in relation to incoming solar radiation.

In practice the sensor measuring incident sunlight is a solarimeter placed outside the greenhouse since it is not practical to place it above the crop. Detection of solar radiation is by means of a thermopile, the analogue output of which is integrated and converted into electrical impulses which are stored in digital counting relays equipped with read out switches. At the end of a predetermined time interval (15-20 mins) the counts stored in the digital counting relays activate a selector to one of 10 possible positions corresponding to 10 levels of solar radiation integral, and this selector activates three resistors, the air temperature and CO2 concentration circuits.

The performance of this controller has been evaluated in a series of experiments by Calvert and Slack at the Glasshouse Crops Research Institute extending over a period of 5 years (Calvert and Slack 1976). In these experiments a constant level of 1000 vpm CO_2 was maintained throughout the enrichment period. 4 day temperature regimes were applied; 2 with light dependent (modulated) control , and 2 with so called "steady" control by normal thermostats. One steady regime corresponding to the original tomato blueprint (night 18.0°C (64°F); day 20°C (68°F) was repeated in each experiment as the control treatment. Altogether 5 different light dependent regimes and 2 others steady regimes were tried during the three years of experiments on day temperature control.

The effects on total monetary returns of light dependent treatments applied in the pre planting stage were small and generally without significance. The effects in the post planting stage (to the end of April when CO_2 enrichment was discontinued) varied according to the program used and the radiation levels, particularly in the months of March and **IVO .** An impressive result was achieved with light dependent control in the first experiment when radiation levels were above average, but this contrasted with a relatively poor performance in the third experiment year when radiation levels were generally low.

Much of the advantage gained when the best light dependent regime operated in above average light conditions **nNst** have been due to the incorporation of a ventilation temperature higher than that which operated for the control treatment since a similar advantage was gained with a steady regime where the temperature was allowed to rise naturally to the higher ventilation temperature 26°C (80°F). In fact the greenhouse itself acts as a light dependent controller on conventional thermostat control under conditions of high radiation, and the effect of a higher ventilation temperature was anticipated from knowedge of the interaction of CO_2 enrichment with temperature (Gaastra 1966).

The experiments have therefore shown that it is possible to get significantly higher monetary returns with both light dependent control and steady regimes modified to the higher ventilation temperature. It is doubtful, however, whether the best light dependent regime was significantly better than the most successful steady regime in a good light year. In a poor light year the results are likely to be significantly worse.

Further experiments have been carried out with the light modulated controller to examine the effects of modulating night temperature on the basis of the previous day's radiation. This was prompted in part by the observation that a high rate of photosynthesis during the day, associated with high radiation, was followed by a high rate of respiration at night. It was suggested that a lower night temperature might slow down the rate of dark respiration and thereby save fuel without a commensurate loss of yield since a high rate of dark respiration was assumed to be wasteful of assimilate.

In the first experiment (Calvert and Slack 1977), light dependent night temperature control was compared with two constant temperatures (16 and 18°C). No significant differences in yield or monetary returns were recorded in the preplanting stage, but in the post planting stage both early yields and values were significantly reduced in both the lower variable and lower constant temperature regimes. Total yields and returns for the variable treatments were slightly higher than for the two constant temperatures, but not significantly so. In a second experiment (Slack and Calvert 1978) the effects of within night temperature changes on fruit production were examined. Differences in the pre-planting stage were small, and in the post planting stage early yields were greatly reduced with the lower mean night temperatures. The results suggest that no financial advantage is gained (taking into account market returns and the cost of fuel) from mean night temperatures above 16 C in the pre planting and 14 C in the post planting stages.

The general conclusions from these exhaustive experiments is that, despite the precision of temperature control in modern greenhouses, a light modulated controller does not appear to be beneficial at this stage. The same conclusion appears to be true for the Dutch4d x control system, which operates on the basis of maintaining the moisture saturation deficit in the greenhouse atmosphere at a constant and appropriate value (van Drenth and Achterberg 1969). Although some 200 of these controllers have been installed on grower's holdings, there have been few reports of their continuing use.

Carbon dioxide

It is worth recalling that as early as 1916 in the Second Annual Report of the Experimental and Research Station at Cheshunk the predecessor of the Glasshouse Crops Research Institute - an account (Lister 1917) was given of the measurement of carbon dioxide in the greenhouse atmosphere which showed that it could reach four or five times the ambient concentration at soil level, whereas at the top of the house it was only just above ambient although during the night the concentration normally rose. Some of the first experiments to investigate the possibility of increasing yields in greenhouse crops by carbon dioxide enrichment were done at Cheshunt by Timmis (1923). These experiments involved the injection of carbon dioxide into the greenhouse in concentrations up to ten times ambient. Owen et al (1926) and Small and White (1930) demonstrated increased yields of tomatoes and cucumbers in greenhouses enriched with carbon dioxide from several different sources; and Bolas and Melville (1935) obtained yield increases of tomatoes of nearly 14% over the whole cropping season from enrichment with carbon dioxide produced by burning paraffin.

Experiments continued up until the war.There was then a long gap until the 50s and early 60s when there were reports of increased yields of cucumbers, tomatoes and heat lettuce from several European countries (Kilbinger 1951, Briejer, 1959 and Klougart 1964) and North America (Wittwer and Robb 1964). In the UK ,Gardner (1964) demonstrated the value of carbon dioxide enrichment for heat lettuce and winter flowering chrysanthemums at the Lee Valley Experimental Horticulture Station. The rapid developments in glasshouse engineering and control instrumentation that derived from the work of L.G.Morris and his colleagues at the National Institute of Agricultural Engineering pointed the way for much more precise and integrated control of environmental factors including carbon dioxide.

This work was paralleled at GCRI by biological studies of the response of greenhouse crops to the integrated control of temperature, ventilation and carbon dioxide. Thus, it has taken 50 years to exploit commercially the original observations of the advantages of CO2 enrichment, but it must be recognised that the technique did not become practically feasible until systems of automatic control of temperature and ventilation were generally available. Even today it is probable that only about a third of the heat tomato acreage in the UK is CO2 enriched, although virtually all the early crop which shows the greatest benefit is. In Holland, the area of protected crops that is enriched is almost certainly higher because with natural gas heating systems it is possible to pipe the flue gases directly into the greenhouse environment. In a series of experiments on CO2 enrichment of early tomato crops, Slack and Calvert (1972) and Calvert and Slack (1975, 1976) were able to confirm the work of Gaastra (1959) which had been carried out on single tomato leaves, showing that a level of three times the ambient concentration of CO2 (1000 vpm) is optimal for this crop.

The effects of enrichment at three levels (600, 1000 and 1400 vpm) were studied on a number of factors affecting yield and quality in both the pre-planting and post-plantimg stages:-

i) Date of flowering

Pre planting enrichment induced earlier flowering throughout the first 10 trusses, although earliness diminished from about six or seven days at the first truss to two or three days at the tenth truss. Differences between the enrichment levels were small but consistent; 1400 vpm was one day earlier than 1000, and this in turn was two days earlier than 600 vpm. There were no significant differences between the three levels of enrichment in the post planting stage.

ii) Fruit numbers

The were no clear out differences in the effects of enrichment in the pre planting stage but fruit development on the first truss was clearly improved. In the post planting period, fruit numbers were increased by enrichment.

iii) Fruit yield and fruit quality

Significantly higher yields and values resulted from enrichment in both pre- and post-planting stages. Actual increases in yield of enriched over non-enriched were 136% at 600 vpm; 149% at 1000 vpm; and 148% at 1400 vpm. There was some improvement of grade-out with pre-planting enrichment but not with post-planting.

In another experiment Slack and Calvert were able to show that reducing the duration of the enrichment period in the pre-planting stage had little effect, but reductions in the post-planting stage caused significant reductions in yield which ware roughly proportional to the reduction in enrichment time. It appeared that reducing the duration of enrichment in the afternoon was preferable to the morning, suggesting some differences in photosynthetic efficiency after midday. Father surprisingly, varying the frequency of water applications during the CO2 enrichment period from every second to every eighth day, had little effect on yield.

One of the more dramatic effects of CO_2 enrichment is the amelioraticn of abortion in the first truss. Comparative figures for enrichment in the pre-planting stage showed 53% at 1000 vpm; and 11% at 1400 vpm. The most likely explanation for this is that in low light CO2 increased photosynthesis in the same way as does extra light with a consequent benefit to the developing truss. Hurd (1968) estimated that CO2 enrichment at 1000 vpm roughly corresponded to an increase of 30% in the level of winter light.

Relative humidity

This environmental factor has received less precise attention than the others, although a good deal of experimental work has been done on the general effects of high relative humidities. The only reference to humidity in the ADAS Tomato Blueprint is to the risks of a high relative humidity in the rapid development and spread of disease. Damping down is widely practiced in tomato cropping, both to avoid water stress and to cool the plants. It also improves fruit setting by raising the humidity around the plants and dislodging the pollen. In greenhouse control systems a humidistat is sometimes installed to operate the ventilation system to expel moisture laden air from the house when the relative humidity rises to a predetermined level and day pipe heat is applied for similar reasons.

THE ROOT ENVIRONMENT

The factors that need to be controlled in the root environment are the substrate and the supply of water, nutrients and oxygen (the last especially in hydroponic systems).

Substrate

Soil and soil-based composts: The trend in recent years has been away from the traditional culture in border soil. This is due in part to the high labour costs involved in preparing the soil, and in soil sterilization by steam or chemical fumigation, which is essential for the control of soil borne pests and diseases. Some use has been made of soil-based composts in troughs where peat and grit are added to the greenhouse *soil*. The use of troughs demands more frequent watering to avoid water stress. Crops must be watered once or twice daily so that an irrigation system is essential. Low level spraylines are used to ensure that the compost is maintained at field capacity. Alternatively, watering from below can be achieved by using a capillary watering system such as One deVised by the NTAE.

Peat: The major development in recent years has been to culture in peat either mixed with various additives such as Perlite and. Vermiculite,•and with sand and grit in troughs or with straw in cucumber culture. The most rapid change, however, has *been* in the development of the use of fertilised peat filled into bags or "modules" (350 mm x 1000 mm, or about 15" x 40"7. These modules are extensively used for tomato production and account for about a quarter of the U.K. heated tomato crop and virtually the whole of the production on Guernsey. Each module made of 500 gauge polyethylene supports 3 tomato plants, and the modules are usually laid on laminated plastic sheet with the black side down and the white side up to increase reflectance and to control weed growth and the ingress of disease from the border soil. Plants are stood on the modules at the normal time but are not usually planted until the first truss is set. Peat is light in weight and has a high water holding capacity, coupled with good aeration. It has, however, little "buffering" capacity, and with the small root volume of the modules it is essential that water and nutrients are applied with great precision so that drip irrigation is invariably used. The amount of water applied is usually determined on the basis of the daily integral of solar radiation (Morris et al 1957), the figures for which are made available in the U.K. through ADAS. Analysis of Peat at monthly intervals is important to ensure that the level of nutrients is correct and that the plants are kept in proper vegetative/fruiting balance.

Peat can also be used in a continuous drip irrigation system in which there is an unlimited supply of water and nutrients to the root zone of each plant. The surplus solution which runs off can in such a system be collected and recirculated.

Rock Wool: Rock wool as a medium for growing crops in gullies has been attracting Increasing attention from growers, especially in Sweden, Denmark and Holland. The total area *in* Holland, where it is used exclusively for cucumber crops, was reported to have reached 25 ha in 1977 (Verwer 1978). The system is essentially one of continuous drip irrigation, and the use of rock wool provides some "buffering" capacity lacking in a fully hydroponic ,system. It is claimed that cucumbers grown in this system are one week earlier than a comparable soil-grown crop, are of better quality and yield some 10-15% more.

At the Institute of Agricultural Engineering at Wageningen, tomatoes have been grown at a lower air temperature by using a root heating system. This system, installed under the roots of the tomato plants and operating at 40°C, allowed a night temperature of 12°C to be used in the air environment apparently without loss of yield (Verwer 1978).

Hydroponics culture - Nutrient Film Technique (NFT): Static hydroponic culture has been attempted commercially for vegetable crops, and especially for tomatoes, for many years. As long ago as 1938 the Agricultural Experiment Station at Berkeley, California, published a circular "The Water Culture Method for Growing Plants without Soil", the authors being Hoagland and Arnon (1938). Nutrient Film Culture was developed in 1966 as a research technique, but it was Cooper (1975) who first saw its commercial potential. The basic principle is a simple one of circulating a shallow stream of solution containing the essential nutrients over the roots of growing plants to provide adequate aeration and adequate supply of water and nutrients. Whilst the concept of the "nutrient film" is probably original, the idea of circulating the nutrient solution is certainly not. There is evidence to indicate however that, in terms of crop growth, nutrient film culture has advantages over a deep, circulating system of hydroponics even when this is adequately aerated.

Methods of Nutrient Film Culture

A slope of 1 in 75-100 is prepared on the glasshouse floor, with care being taken to ensure that the surface is even so that problems do not arise with pools of nutrient solution forming in the gullies. A gully in which the plants are grown may be formed from rigid or semi-rigid plastic or polyethylene film or raised on supports. It should have a base of about 250-300 mm with an arrangement of clips along the top to enable the gully to be closed around the stems of plants to exclude light. A capillary matting of synthetic fibre is usually placed in the bottom of the gully. A range of gully types is available commercially in both Europe and North America, and some growers have fabricated their own gullies from polyethylene film.

The experimental approach to flow rates for the nutrient solution has been largely empirical, but is commonly about 1-3 litres per minute from the inlet tube although some growers use a much slower flow rate. Similarly the length of the gully varies considerably, but probably should not exceed 30 metres. The other essential components of the system are the circulating pumps and the storage tanks for the nutrient solution. A range of submersible pumps are available commercially, and there are differing views on the requirements of the storage tanks. Some growers favor a tank capacity of only 10 per cent of the total nutrient solution circulating. Others will use a much larger proportionate capacity. In all cases *alarm systems are* necessary to protect against pump failure.

Various methods of propagation have been tested from bitumen/fibre pots containing loam or loamless composts to various types of aggregate and rock wool cubes.

Nutrition

Conventional nutrient solutions used in hydroponics such as those published by Hoagland and Amon (1950), and Hewitt (1966), have proved ,effective in nutrient film culture and have in some instances been modified. The original formula of Cooper is shown in Table 2.

Table 2: Nutrient Solution (Cooper 1975) for nutrient film culture of tomatoes

Element	Average ppm achieved in solution	Source of Supply	Average rate of supply (grammes/ plant/Week)
Nitrogen	206	Potassium nitrate	2.25
		Calcium nitrate	2.08
Potassium	250	Potassium nitrate	given above
		Potassium phosphate	0.088
Phosphorus	39	Potassium phosphate	given above
		Phosphoric acid	0.36 millilitres
Calcium	237	Calcium nitrate	given above
Magnesium	78	Magnesium sulphate	1.63
Iron	2.80	EDTA iron	0.11
Manganese	0.79	Manganese sulphate	0.014
Copper	0.06	Copper sulphate	0.0002
Molybdenum	0.02	Ammonium molybdate	0.0001

Automatic control of conductivity has been widely adopted, and this is generally held at levels above 2000 micromhos. It allows the nutritional requirements of the crop to be met satisfactorily although imbalances can develop and give rise to deficiency symptoms even though the conductivity readings remain high. It is also argued that higher concentrations can be used to stress the plants osmotically but there is no clear evidence on this aspect and, indeed, plants can tolerate concentrations up to 6000 micromhos without apparent reduction of vigour.

pH is automatically controlled in most installations at pH 6-6.5 to ensure that phosphates and trace elements remain in solution. Adjustment of pH is normally made with phosphoric or nitric acids.

Winsor and Massey (1978) have demonstrated that a tomato crop can be grown in nutrient film culture at surprisingly low levels of nitrogen and potassium. Root growth, the lack of which can be a problem in nutrient film, was actually increased at low nitrogen levels. The nominal treatment concentrations in parts per million (ppm) in their exneriments were 10 N + 100 K, 85 N + 20 K and 10 N + 20 K. Supplementary pumps in the system ensured that concentrations were maintained at these levels around the roots of the plants. In such a system tomao plants grown to six trusses remained entirely free of deficiency symptoms at maintained concentrations of 10 N and 20 K ppm, but if the supplementary pumps were disconnected then deficiency symptoms quickly appeared and persisted throughout cropping and the plants were found to have taken up only half the amount of nitrogen as compared with plants grown at maintained levels. Plants grown at maintained levels of 10 ppm N were as vigorous as those grown at 85 ppm N showing that very low nutritional levels were sufficient in a fully maintained system.

Uptake of nutrients was found to be directly related to water uptake, and this in turn to solar radiation. Although we do not as yet have precise information, it appears that plants grown in nutrient film culture **in** glasshouses require about 85 per cent of the water that would be applied to a soil-grown crop on the basis of daily integral of solar radiation.

Tomatoes were found to be especially responsive to different sources of nitrogen. Where, for example, half the nitrogen was supplied as the ammonium ion, plants showed poor leaf growth with grey colored foliage, whereas when the supply was exclusively in the form of nitrate nitrogen, the foliage was luxuriant and dark green in color. Ammonium-N has the added advantage of keeping the pH down although at levels of 100 ppm it appears to have a toxic effect which may be due to the excessive acidity it causes.

The overall quality of fruit from experiments and from commercial production has been very good.

Root temperature

One of the features of nutrient film culture of protected crops that has attracted interest is the suggestion that it will be possible to heat the circulating solution and so save energy by using lower temperatures in the aerial environment. To date no critical experiments have been done on this aspect of root temperature control at different air temperatures, but Moorby (1977) has examined the effects of temperature on the growth, uptake of nutrients and yield of tomato plants in a circulating nutrient solution.

A 10-truss crop of tomatoes was grown in each treatment in a fully insulated and aerated deep hydroponic culture system and compared with a crop grown in the border soil of the same house. The uptake of N, P and K from the solutions was estimated from . regular analyses, and additionally plants were analyzed for these major nutrients.

The results are presented in Table 3. There was a positive relationship between root temperature and water and nutrient uptake. There appeared to be little uptake of phosphate at 14°C, and the yield was small but the quality in terms of total dry matter, reducing sugars and acidity was surprisingly good. The root system at this temperature was much more restricted, and it is possible that this selectively affected phosphate uptake. It is unlikely to have been attributable to the factors that affect phosphate uptake in soils such as the low diffusion rate of the phosphate ion. The advantage of the higher root temperatures persisted throughout the period of cropping so that the later trusses were much heavier than the corresponding trusses on plants grown in the border soil.

Table 3: Effect of root temperature on the growth, uptake of nutrients and yield of tomatoes group in circulating nutrient solution. (Moorby 1977)

Root/Air Temperature	(°C)	14/18	18/18	23/18	soil/18
Mean Dry Wt per plant (g)		250.50	397.68	676.21	362.90
Concentration (mg g $^{-1}$)	N	19.56	23.97	21.46	22.92
	P	4.47	5.75	5.70	3.86
	K	33.60	40.94	43.57	44.55
Total amount in plant (g)	N	4.90	9.53	14.51	8.32
	P	1.12	2.29	3.86	1.40
	K	8.42	16.28	29.46	16.17
Fruit yield (Kg/plant)		2.22	3.36	6.45	3.90

An experiment at Fairfield Experimental Horticulture Station of ADAS showed that it was possible to lower the night temperature of a tomato crop to 9°C without loss of yield by heating the circulating solution to 25° C. In an experiment in the current year with an early tomato crop, Cooper and Moorby (unpublished) have examined the effects of heating the solution at five different temperatures (20, 23, 26, 29 and 32°C), and a single air temperature of 20 C day and 9°C night. A control with unheated solution was grown according to blueprint (20°C day, 18-15°C night). There were no marked differences in the early yields for all treatments, but when the plants were pulled out on the 29th June the cumulative yields showed small differences only between the four higher temperature treatments but the 20°C solution gave 12% lower yield. Although this was an experiment conducted at one air temperature only it does give promise that heating the circulating nutrient solution will allow of a lower night temperature in the aerial environment, thus saving fuel. Orchard (personal communication) has conducted a more elaborate experiment on Guernsey this year. In general, his root warming in *NFT* has given similar results to Cooper and Moorbyls. There was no benefit however in peat from root zone warming. In neither trial was there evidence of an interaction between root temperature and air temperature.

Root death

There have been instances of poor growth and fruiting once the early crop has been picked from November sown tomatoes grown in nutrient film. Generally, the growth in nutrient film is good with higher flower numbers than in soil-grown crops, but in April-May the leaves of nutrient film grown plants can wilt and the middle trusses either fail to set or give low yields. This problem has been found to be associated with root death and occurs also in cucumbers. Affected tomatoes eventually recover in early June and vigorous, healthy, roots replace the dead root mat. In cucumbers, however, wilting can be much more severe and the plants may die.

Growth analysis studies of the tomato by Hurd and Gay (1977) have shown that in young plants the rates at which shoot and root gain in weight are at first similar, but whilst shoot growth (including fruit) continues at a fairly constant rate, root growth ceased about 4 weeks after anthesis of the first truss.

With the onset of fruiting, vegetative growth of both shoot and root is reduced, and root extension growth diminishes to zero, subsequent root growth being confined to the production of fine roots on the existing main network so that there is no net gain.

The vegetative shoot also stabilizes in size at this time with the production of new leaves being balanced by an equivalent loss of old leaves (in commercial practice they are removed manual:10 with the result that the root-shoot ratio remains constant. This pattern of root growth and root death is not, however, peculiar to nutrient film culture but occurs also in. soil. It is more dramatic in hydroponic culture because the dead roots are obvious, but it does not appear to be associated with a primary fungal pathogen. Price (1977) has shown that 112 – 12phthora ervthroseptica, a weak pathogen of solanaceous plants, can consistently be isolated from the root mat. However, no plants were killed by this fungus and no other known pathogens were identified. Attempts to induce root death by the deliberate introduction of pathogens have also been inconclusive (Staunton and Cormican 1978; Price 1978).

A simple explanation for root death might be that increased demand for carbohydrates by the developing fruit starves the root system. This could be more pronounced in nutrient film crops since the earlier yield can be heavier than in a conventional soil-grown crop and there may therefore be a greater imbalance of vegetative to reproductive growth in the early fruiting stage. Other studies by Tucker (1977) have, however, revealed that there is a build-up of cytokinins and auxin in the circulating nutrient solution in tomato crops. The level of cytokinins rose from 3 ppm on the 26th March to 80 ppm on the 5th May, and then fell sharply to reach 0.4 ppm by mid-July. Changes in auxin followed a similar pattern with the corresponding figures being 0.1, 5.0 and 0.3 ppm. The date of peak concentration of both hormones corresponded with the time of maximum root death, and the subsequent rapid fall in levels was associated with root recovery. Attempts have been made by Hurd (1978) to induce root death by growing plants in solutions with high levels of cytokinins but without success.

Recently it has been suggested that root death could be caused by the toxicity of iron chelates, particularly EDTA. Concentrations of EDTA above 10 ppm are known to *be* toxic (Hewitt 1966), and EDDHA appears to be more satisfactory although this chelate can cause manganese deficiency. Clearly the management of trace elements and particularly iron in NFT requires further study.

Future prospects for environmental control in vegetable crop production

If the production of fresh vegetable produce is to continue profitably in greenhouses and outside the natural season of production, then it must be profitable for the grower in competition with imports from more favorable climates. We may assume that the demand for such fresh produce will continue and, indeed, may increase with the rising standards of living in some developing countries.

Research must be directed at reducing the unit cost of production. An analysis of the U.K. situation shows that two-thirds of direct costs are attributable to fuel and labor in roughly equal proportions. Similar costs appear to apply where cooling rather than heating, or a combination of heating at night and cooling during the day, is necessary for the control of the aerial environment. It is apparent that the trend must be towards more efficient *use* of energy coupled with energy conservation and production at lower temperatures. The high capital cost of greenhouses demands also that the fullest possible use should be made of them by cropping for as long a period as possible, if not year-round.

Culture out of the border soil in peat, rock wool or in nutrient film, *has* a number of economic advantages stemming from the ability to control precisely the root environment, although the initial cost of such installations is high. The immediate benefits are:-

1. Saving of labor in soil cultivation and sterilization, and in pulling out and replanting crops.

2. More precise control of the use of water and nutrients.

3. More rapid "turn-round" of crops so that greenhouses can be cropped throughout the year.

The possibility of heating the root environment with peat modules, rock wool or NFT, so that fuel can be saved by maintaining the aerial environment at lower night temperatures.

Mora research is needed on nutrient film culture before a definitive blueprint can be specified for this system. In this connection the empirical approach which has ben adopted by many growers must be accepted as inevitable against the background of the comparatively short period of tine during which this system has been developed. It is salutary to recall that, whilst it took nearly 50 years to devise the successful commercial application of CO2 enrichment, NET has only been practiced over a period of less than 10 years. Nevertheless if peat is looked upon as a finite resource that will become increasingly expensive, then we may expect it to be replaced in time by a hydroponic system. Such a system lends itself also to further automation and, in the light of modern technology, to control by microprocessors.

Whether more dramatic improvements in yield can be obtained remains to be seen, but it is certain that improvements in quality can be achieved through the kind of environmental and nutritional control which is feasible in nutrient film culture.

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V. NEW JOURNAL-REVUE NOUVELLE

Irrigation Science

Irrigation Science will publish original contributions and short communications reporting the results of irrigation research, including relevant contributions from the plant, soil and atmospheric sciences as well as the analysis of field experimentation. Special emphasis will be given to multi-disciplinary studies dealing with the problems involved in maintaining the long term productivity of irrigated lands and in increasing the efficiency of agricultural water use.

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-Salinity and alkalinity control by soil and water management
-Ecological aspects of irrigated agriculture.

Subscription information : D.M. 148 for subscription rate
Editor: Springer Verlag Heidelberger Blatz 3 D 1000 Berlin 33

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VI. ESNA. European Society of Nuclear Methods in Agriculture. ESNA

Editor's Note. The Secretariat of ESNA has kindly sent us "Proceedings 1977 of VIIIth Annual Meeting (29 August- September 2) at Uppsala (Sweden). We reprint the table of contents.

VII. NEW BOOKS

a. Arabidopsis Information Service

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

The newsletter is intended to cover all aspects of research with Arabidopsis and related species. It provides a forum for the publication and discussion of current research news, especially in genetics, but also in ecology, physiology , development, and molecular biology. The newsletter is also open to all information on methods, materials and stock exchange as well as to laboratory research communications dealing with tentative experimental results and research programs underway. It is hoped that by such a policy the newsletter will extend to international communication on Arabidopsis research.

At present one number is issued annually in October

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CETL I.Genoclinal character of flowering time variability in Arabidopsis thaliana (L.) Heynh.

USMANOV P.D., V.I.MUZIKA, I.G.NEDNIK, N.V.GLOTOV , V.A.SHEVCHENKO, and S.A.FAMELIS. Population genetics of Arabidopsis in the west Pamir Alai. Report I.Comparative characteristic of the Arabidopsis populations on the Hissar mountain ridge (German with English abstract).

KRANZ A.R. Demonstration of new and additional population samples and mutant lines of the AIS-seed bank.

C.Information

Workshop on Arabidopsis Genetics, Moscow 1978.

D.Bibliography

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b. A growth Chamber Manual. Environmental Control for Plants I

Edited by Robert W. Langhans

1978. Comstock Publishing Associates. A division of Cornell University Press-Ithaca and London. 240 pages.

All aspects of the proper maintenance and operation of growth chambers are covered in this authoritative guide prepared by the Committee on Growth Chamber Environments of the American Society for Horticultural Science. Focusing primarily on sophisticated growth chambers used for experimental purposes it is both an introduction for the beginner and a complete reference for the more knowledgeable.

Thirteen experts explain growth chambers work, how to provide precise control in growth chambers, and how to avoid many of the problems associated with their operation. They provide detailed technical information on preparing specifications, controlling and measuring environmental conditions, growing plants, disease and insect control, general maintenance costs of operation, and experimental designs.

Greenhouse operators, students, commercial plant growers, teachers, and experimentalists all will find in this one source book the information vitally important for keeping a plant growth chamber running at optimum conditions.

Contents

c. Problems of Drought Resistance of Plants (in Russian)1

Editor , Prof.A.A.Prokofiev, 1978, Ed.Nauka, Moscow, 254 p.

This book unfortunately published in Russian, without any comments in other languages is of great interest to physiologists, biochemists working with plants and agronomists. It deals with basic current problems concerning plant's resistance to drought: the influence of high temperatures on plant organs, the action of dehydration on the state of chloroplasts, the physiological processes of endurance to drought of plants before sowing. The work on the diagnosis of resistance to drought as well as the mechanization of the process of endurance are in close relation with culture. The articles of general interest abundantly analyze Soviet scientific works as well as those in other countries.

Table of Contents

P.A.Filatov and R.I.Frolova Secondary Effects of Endurance before Sowing of Spring Wheat Grains in Second and Third Generations.

E.C.Zlobina Observations under Culture and in the laboratory on Gutation and Transpiration.

N.I.Antipov, Intensity of Cuticular Transpiration of Herbaceous Plants under Different Ecological Conditions

P.A.Henckel On the Particularities of the Growth and Development of Salicornia herbacea L. in the Desert of Solontchaks of Dacht-i-Kaviz.

x

d. La Sensibilite des plants. A Tronchet. Editor Masson, 120 Bd St Germain, 75280. Paris Cedex 06 1977, 158 pages

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VII .LIVRES NOUVEAUX - LIST OF NEW BOOKS

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Annual Report 1977. Institute of Terrestrial Ecology. Monks Wood Experimental Station Abbots Ripton Huntington PE17 2LS Cambs. U.K.

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J.L.HARPER. Population Biology of Plants. Academic Press Ed. New York 1977. 892 pp. S. 58,60.

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A.A.PROKOFIEV, editeur. Probnmes de resistance a la secheresse *des* plantes (en Russe) Ed.Nauka Moscou 1978. 254 pages.

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N.ZIESLIN and all.Effect of night temperature and growing practices on the winter yield of roses. Sciencia Horticulturae 8 (1978) 363-370.

IX. REUNIONS ET EXPOSITIONS ANNONCEES
COMING EVENTS, MEETINGS AND EXHIBITIONS

1979. ler trimestre. Gembloux on Louvain (Belgique).
4e cycle,Seminaires de perfectionnement: Phytotechnie et Physiologie des Plantes de grande culture :

12 janvier. Louvain. Physiologie du rendement, photosynthese translocation et accumulation.

19 janvier. Louvain. Complementation mitochondriale. Physiologie des relations hydriques. Influences des conditions hydriques sur les rendements.

2 fevrier. Louvain. Aspects physiologiques de la nutrition minerale des plantes.

9 fevrier. Gembloux. Fertilisation phospho-potassique des plantes de grande culture.Etat calcique et magnesium des sols.

16 fevrier. Louvain. Cycle biologique de l'azote et productions proteiques.

23 fevrier. Gembloux. Dynamique de l'azote et fumure azotee.

2 mars. Louvain. Fertilisation des prairies et physiologie de la qualite desfourrages.

9 mars. Gembloux. Conduite et entretien de la prairie permanente.

16 mars. Gembloux. Phytotechnie *des* cereales

23 mars. Gembloux. Techniques betteravieres actuelles et problemes d'avenir.

30 mars. Louvain. Phytotechnie de la pomme de terre caracteres quantitatifs et qualitatifs de la production Phytotechnie du mais.

Renseignements: Secretariat 4e cycle: J.F.LEDENT. Laboratoire d'Ecologie vegetale. Place Croix du Sud 4. 1348 Louvain La Neuve.(Belgique).

1979 15-18 janvier Grignon (France)

Cycle de Formation continue: la lutte biologique par des organismes vivants

Renseignement: ADEPRINA, Mme EWALD 16 rue Claude Bernard, 75231, Paris Cedex 05.

1979 January 26-february 4 Berlin(GFR)

International Green Week
Info: Ausstellungs.esse.Kongress. GmbH Messedamm 22 D 1000 Berlin 19.PR)

1979 1-2 fevrier Paris (France)
Colloque CNIH "Espaces verts" .Les vegetaux en conteneur: distribution, utilisation. Pour une meilleure connaissance des plantes vivaces.

Renseignements: CNIH-Service Economique BP 309, 94152 Rungis Cedex (France).

1979 February Christchurch (New Zealand)

Int.Symposium on reproduction in flowering plants.
Info: E.J.GODLEY Botany Div.Dept. of Scientific and Ind.Research.Private Bag Christchurch (N.Z).

1979 6-8 fevrier Lyon (France)

Cycle de Perfectionnement Invuflec: Methodes biologiques appliquees aux cultures legumieres

Renseignements: INVUFLEC 22 rue Bergere, 75009-Paris.

1979 6-9 fevrier Angers (France)

Session de formation continue: Culture florale sous abris (oeillet et gerbera)

Renseignements: ENITH rue le NOtre 10093-Angers.Cedex

1979 13-15 fevrier Grignon (France)

Cycle de Formation continue: Recolte mecanique des produits fragiles: legumes et fruits

Renseignements: ADEPRINA, Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 13-15 fevrier France

Cycle de Perfectionnement Invuflet: Irrigation goutte à goutte et irrigation fertilisante sur cultures maraicheres.

Renseignements: INVUFLEC. 22 rue Bergare 75009 Paris

1979 February 14 Peterborough (UK)

Conference on Vining Peas

Info: A.J.GANE. PGRO Res.Sta.Great North Road.Thornhaugh Peterborough PE8 6 HJAIK.

1979 19-20 fevrier Carpentras serres (France)

Formation permanente: Organisation et programmation des cultures:travaux et productions en pepinieres

Renseignements: ANIFORM BP 309 94152 Rungis Cedex

1979 27 fevrier- ler mars France

Cycle de perfectionnement INVUFLEC: Materiels et techniques des semis et plantation en cultures legumieres

Renseignements: INVUFLEC, 22 rue Berge¯re 75009-Paris

1979 February 27- ;larch 3 Mexico

find International Seminar on plastics in agriculture

Info: Secretary Paseo de la Palmas n°755, 7e Piso Mexico DF

1979 Spring Avignon (France)

Multidisciplinary meeting on "Growth optimalisation through microclimate control

Inquiries: K.W.WINSPEAR-NIAE. Wrest Park Silsoe Bedford MK 45 4HS (UK)

1979 March Kerala State (India)

ISHS Symposium on Cashew nuts

Inquiries: J.G.OHLER Tropical Institute: Mauritskade 63 Amsterdam 0 The Netherlands.

1979 5-9 mars Grignon (France)

Cycle de formation continue: Utilisation de la microinformatique: ses possibilites dans les relations avec les agriculteurs

Renseignements: ADEPRINA Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 March 12-14 Madison (USA)

Controlled Environments Working Conference

Info: Prof.T.W.TIBBITTS Horticulture Dept.Univ.of Wisconsin Madison Wto- 53706 USA

1979 March 21 Peterborough (UK)

Conference on Mechanisation in the Production of Vegetables for processing

Info: A.J.GANE PGRO Res.Sta.Great North Road Thornhaugh Peterborough PE8 6RJ (UK).

1979 30 mars-2 avril Bordeaux (France)

Ire Exposition florale d'Aquitaine

Renseignements: Comite *des* Foires de Bordeaux BP 55 Grand Parc 33030.Bordeaux Cedex

1979 April 1-7 Canterbury (UK)

ISHS Conference on mineral nutrition and fruit quality of temperate zone fruit trees

Info: Dr.D.ATKINSON.East Nailing Research Station Maidstone Kent ME 19 6 B..1 UK.

1979 3-5 avril France

Cycle de perfectionnement INVUFLEC Culture sans serre

Renseignements: INVUFLEC, 22 rue Bergere 75009-Paris

1979 5-10 avril Bordeaux (France)

Exposition florale de Bordeaux

Renseignements: M.D.GONZALES. Martignes sur Jalles 33610-Sazinet Cedex 05.

1979 April 6-11 Budapest (Hungary)

9th International exhibition of plastics Materials Hungaroplast

Info: Hungexpo BP 44- H 1441 Budapest XIV Hungary

1979 16-21 avril Kuala Lumpur (Malaysia)

V International Symposium on tropical ecology

Info: Prot.J.I.FURTADO c% Depart.of Zoology Univ.of Malaya Kuala Lumpur Malaysia

1979 17-21 avril Bordeaux France

I04e Congres National des SocietEs Savantes

Renseignements: Secr4tariat du Congres. Bibliotheque Nationale 58 rue de Richelieu 75084 Paris Cedex 02.

1979 18-20 avril Paris (France)

L'energie solaire en agriculture. Cycle de Formation Continue

Renseignements ADEPRINA, Mae EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 24-26 avril Grignon (France)

Cycle de formation continue: Etudes actuelles sur les transferts d'azote dans le sol: fertilisation, pollution, patrimoine organique

Renseignements: ADEPRINA, Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 6-11 May Townsville (Australia)

International Symposium and Workshop on genetic Resources of forage plants

info: Secretary CSIRO Private Mail Bag PO Townsville QLd 4810 Australia

1979 8-10 mai Grignon (France)

Cycle de formation continue: Les microorganismes responsables des maladies des plantes

Renseignements: ADEPRINA, Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 11-21 mai et 23 mai- 3 juin Paris (France)

Floralies internationales de Paris 1979

Renseignements: CNIH BP 309 94152 Rungis Cedex

1979 11 mai-4 juin Paris (France)

4e Floralies Internationales de Paris

Renseignements: Parc floral de Paris. Bois de Vincennes 75012 Paris (France)

1979 13-31 may. Sydney Gosford (Australia)

VIIIth Conference of International Organisation of Citrus Virologists (IOCV)

Info: The Secretary. PM B 10 Rydalmere NSW 2116 Australia

1979 14-17 May. Skierniewice (Poland)

Symposium on Growth regulators in floriculture ISHS
Info : Prof. Dr. **R.** M.RIJDNICKI, ul. Pomologiczna 18, §6100 Skierniewice, Poland.

1979 5-8 June Avignon (France)

Multidisciplinary ISHS meeting on "Growth optimalisation through micro-climate control"

Info: Dr.J.DAMAGNEZ INRA, Domaine St Paul 84140 Cantarel Montfavet France

1979 June 11-15 Alnarp (Sweden)

First Symposium on quality of vegetables

Info: Dr.Torsten Nilsson. Dept.of Vegetable Crops Agric.Col.Sweden
S 230 53 Alnarp Sweden

1979 12-14 Juin France
Cycle de perfectionnement INVUFLEC: Ferlitisation des cultures maraicheres

Renseignements: INVUFLEC: 22 rue Bergere, 75009-Paris

1979 June 25-July I.Budapest (Hungary)

Second ISHS Symposium on Spices and medicinal plants
Info: Dr.P.TETENYI Cyogynovery Kutato Intezet.PF 11, H 2011 Budakalsot
Hungary

1979 8-12 july Hannover (F.R.Germany)

XIV International Conference on basic and applied Chronobiology

Info: ISC XIV Conference.Medizinische Hochschulo, Dept Anatomie D 3000
Hannover 61 Karl Wiechert Allee 9 W.Germany

1979 July 8-13 East Lansing USA

9th International Congress on Rural Engineering organized by Michigan State University and American Society of Agricultural Engineers.

Inquiries: Prof.C.M.HANSEN CIRG Congress Coordinators 113 B Agricultural
• Engineering Bldg Michigan St Univ.East Lansing Mich. 48824 USA.

1979 August Aarslev (Denmark)

Symposium on Production planning in glasshouse floriculture

Info: Dr.V.A.Hallig Glasshouse Crops Research.Station Kirstinebjergvei 10, DK 5792 Aarslev Denmark

1979 August Northen Europe

ISHS symposium on International transport systems for maximizing the labour efficiency of greenhouse

Info: Dr.H.G.GERMING I MAG PO Box 43 Wageningen (Netherlands)

1979 August 20-september 5. Khabarovsk (USSR)

XIV Congress of Pacific Sciences

Info: Organizing Com. 49 Vavilov Str.V333 Moscow 117333 (USSR)

1979 August 27-31 Amsterdam (Netherlands)

IInd International symposium on the role of water into urban ecology

Info: M.K.PLAXTON PO Box 330 Amsterdam (Pays Bas)

1979 September EVORA (Portugal)

ISHS Symposium on production of tomatoes for processing

Info: Associacao Portuguesa de horticultura. Universidade de Evora Apartado 94 Evora. Portugal

1979 4-7 septembre Paris (France)

Stage Technique ACTA:Au Probleme au protocole, des resultats aux decisions (journee preparatoire le 20 mars 1979)

Renseignements: ACTA 149, rue de Bercy 75579 Paris Cedex 12 France.

1979 September 9-14 Shefayim (Israel)

VIIIth International Congress of Biometeorology

Info: Israel organizing Committee. ISB Congress. c/o Israel Meteorological Society PO Box 25 Bet Dagan Israel.

1979 10-28 septembre Paris (France)

Cycle de Formation continue: Microbiologie du sol et des eaux

Renseignements: ADEPRINA , Mme EWALD 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 11-14 septembre Littlehampton (UK)

ISHS-IWOSC Symposium on Research on recirculating Water culture.Nutrient film technique

Info; Dr.R.G.HURD G.C.R.I.Littlehampton W Sussex BN 16 3 PU United Kingdom

1979 14-17 septembre Lyon (France)

Salon HORMATEC 1979 Salon des techniques Hortico-Maraicheres avec journees d'Etudes

Renseignements: Syndicat des producteurs horticoles de la Region lyonnaise. 4 place Gensoul 69287 Lyon Cedex 1 France

1979 September 25-29 Varna Bulgaria

International Symposium on plant nutrition

Info: Secretary; M.Popov Institute of Plant Physiology Bulgarian Ac.Sc. Sofia 1113, C.Boarchev str.biock 6 Bulgarie

1979 2-5 octobre Boigneville (France)

Stage technique ACTA:Experimentation planifiie

Renseignements: ACTA 149, rue de Bercy 75579 Paris Cedex 12 France

1979 15-19 october Belgrade (Yugoslovia)

Xth Annual Meeting of ESNA

Info: PH van Nierop ESNA, 6 Keyenbergseweg POB 48 Wageningen The Netherlands

1979 November 3-6 Los Banos (Phillipines)

ISHS Symposium on problems in fruit and vegetable crop research

Info: Dr.E.B.PANTASTICO Coll.of Agriculture Univ.of Phillipinas Laguna Phillipines

1979 13-16 novembre Grignon (France)

Cycle de formation continue: Proteines foliaires et alimentation

Renseignements: ADEPRINA, Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 26-30 november Sydney (Australia)

VIIth Conference of the Asian Pacific Weed Science Society (APWSS)

Info: The Secretary PO Box 287 Haymarket NSW 2001 Australia

1979 27-28 novembre Paris (France)

Cycle de formation continue: Examen des problemes lies aux aspects d'epidermiologie des plantes

Renseignements: ADEPRINA, Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 10-14 decembre Grignon (France)

Cycle superieur d'Agronomie: enquate ou experimentation ? Leur valeur respective pour l'etude des problemes agricoles

Renseignements: ADEPRINA, Mme EWALD, 16 rue Claude Bernard, 75231 Paris Cedex 05

1979 ou 1980 Wageningen (Netherlands)

ISHS Symposium on vegetable storage

Info: Ir.W.S.DUVEKOT Sprenger Inst.Haagsteeg 6 Wageningen The Netherlands

1979 ou 1980 Israel (?)

Symposium on (rootstocks) fruit quality and yield improvement in Mediterranean citrus

Info: Dr.S.P.Monselise Dept.of Horticulture POB 12 Rehovot (Israel)

1980 6 months.Exposition nationale horticole Bale (Suisse)

1980 Merano (Italy)

ISHS Symposium on High density planting

Info: J.E.JACKSON East Mailing Res.Sta.East Mailing Kent ME 19 6 BJ UK

1980 Italy

ISHS Symposium on Vegetable seed production

Info: Dr.R.A.T.Georg School of Biological Sc.Univ.of BATH Claverton Down Bath Somerset (UK)

1980 Brunswick (RFG)

Fifth ISHS Symposium on virus diseases of ornamental plants

Info: Dr.R.KOENING Inst. fur Virusserologie Messeweg 11/12 33 Baunschweig BRD

1980 May 12-17 Aarslev (Denmark)

Third ISHS Sympbsium on Flower bulbs

Info: Dr.E.RASMUSSEN Stage exp.Station.Aarslev DK 5792 Denmark

1980 Avril Gand Belgique

Floralies gantoises

1980 July 20-25 Strasbourg (France)

8th International Congress on Photobiology

Info: M.CHARLIER Centre de Biophysique Moleculaire lA Av.de la Recherche Scientifique 45045 Orleans Cedex France

1980 August Davis Calif (USA)

IInd Inst.Symposium on Post harvest physiology of cut flowers

Info: Prof.A.M.KOFRANEK Dept of Environmental Horticulture Univ.of California Davis CA 95616 (USA)

1980 August 19-28 (North America)

Symposium on Rubus

Info: H.A.DaMberry Vancouver Res.Sta. 6660 NW Marine Drive Vancouver BC V6T IX2 Canada

1980 15-19 september Dublin (Eire)

ISHS Symposium More profitable use of energy in protected cultivation

Info: Dr.T.M.O' FLAHERTY Agric.Inst.Malahicle Road Kinsealy Research Centre Dublin S Eire

1980 or 1981 (UK ?)

ISHS SYmposium in timing field production of vegetables

Info: Dr.D.Gray Nat.Vegetable Res.Sta.Wellesbourne Warwick CY 35 9 EF UK

1981 Paris (France)

ISHS Symposium on Protected cultivation of chrysanthemums (propagation, flower physiology, nutrition)

Info: ISHS Commission for Protected cultivation. Box 1011 Aalsmeer The Netherlands

1981 Switzerland or Finland

ISHS Symposium on the use of artificial light in horticulture

Info: ISHS Commission for protected cultivation. Box 1011 Aalsmeer The Netherlands

1981 21-28 august Sydney Australia

<u>XIII International Botanical Congress</u>

Info: University of Sydney NSW 2006 Australia

1981 Avril Genes (Italie)

EUROFLORA

1981 or 1982 May San Diego Calif (USA)

<u>IInd Symposium on Protected Cultivation of Carnations</u>

Info: ISHS COmmission for Protected cultivation Box 1011 Aalsmeer The Netherlands.

1982 6 months <u>Floriades des Pays-Bas</u>

1982 29 august- 4 september Hamburg (FRG)

<u>XXI st International Horticultural Congress</u>

Info: The Secretariat Hamburg Congress Centre POB 302360 D 2000 Hambourg 36 F.R.Germany

1982 or 1983 August Aarslev (Denmark)

<u>Production planning of Glasshouse floriculture (ISHS)</u>

Info: V.A.Piallig Research Institute for Glasshouse Crops Kirstinebjergvej 10, DK 5792, Aarslev, Denmark

1983 6 months IGA a Hambourg (FRG)

1984 6 months WIG, Vienne (Autriche)

1985 Avril <u>Floralies gantoises</u> (Belgique)

Nous remercions a l'avance, tous ceux qui nous enverront des informations ou article:; que nous reproduirons, si possible, dans les prochains numeros.

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

R.Jacques and N.de Bilderling .

Phytotronic Newsletter. 18 : 81 -84. The Biology of Crop Productivity.Â Earth in the balance: Ecology and the human spirit: by Senator Al Gore, Houghton Mifflin Company, 19 November 1992 Â· Trends in Ecology & Evolution. J. Hall Cushman.