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GLASSHOUSE CROPS
RESEARCH AND EXPERIMENT
STATION
NAALDWIJK THE NETHERLANDS

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CONTENTS

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3. DIRECTOR'S REPORT

DEVELOPMENTS IN THE DUTCH GLASSHOUSE INDUSTRY

Last year was not unfavourable for the Dutch glasshouse industry. Compared with the previous year, profitability was improved, particularly in the glasshouse vegetable industry, but also to some extent in flower growing. The effects of the weather, foreign competition and a number of other factors have all played a part in this.
The favourable results, compared with 1982, have also stimulated new investments. Most of the investments have been in the area of energy-saving equipment, although there is also renewed interest in glasshouse building. Research has a close link with the developments taking place in commercial horticulture. It stands to reason therefore that research into energy saving aspects has a very high priority which is likely to remain so in the years ahead. The work in this area is still expanding to some extent.
In the same context, renewed attention has been given to CO_2 enrichment. The reason for this was the discovery that in well-insulated glasshouses the CO_2 levels can become very low. The development of improved monitoring and dosing methods made it possible to control the CO_2 levels in the glasshouse.
The switch from growing in soil to crop production in artificial substrates continued unabated. There are several reasons which explain the increasing interest in substrate growing. The possibility of increased yields has no doubt a stimulating effect, but other important reasons are improved growthcontrol, particularly in relation to energy-saving measures, the problems with soil disinfection and also the possibility of achieving energy savings. The developments in substrate growing are particularly remarkable in glasshouse vegetable crops, but interest in the flower growing industry is also increasing. In 1983, the area of crops on substrates reached some 1,400 ha, with most of the crops being grown on rockwool.
The use of methylbromide for soil disinfection decreased, partly as a result of the change over to substrate growing. Replacement chemicals for methylbromide proved satisfactory to a very limited extent only.
The paramount importance of high light transmission in glasshouses was proved again in both research and practice, especially in the glasshouse vegetables.

PROGRESS IN RESEARCH

Department of soils, water and nutrition

Apart from nutrition research in several minor crops, attention was given particularly to exploring the relationship between nutrition and quality. The relationship with the nitrate content in a number of vegetables was studied in particular. It was found to be difficult to reduce the nitrate contents to any extent via the nutrition of the crop under low light intensities during the winter months.

The relationship between plant nutrition and quality was also studied in the context of the application of energy-saving measures. This offers an important area for research containing aspects which, within the framework of wideranging substrate investigations, will also receive special attention in the coming years.
Bromide investigations were also part of the research into produce quality. Bromide levels in the soil showed an increase after steam sterilisation which resulted in an increase in the bromide contents of the crop.
Of a totally different nature is the physical potting compost research which is being carried out with the aim to develop specifications for the quality of potting composts. Potting compost manufacturers in particular showed great interest in this research.
The increased use of the computer in research work should be mentioned. A start was made on designing nutrition programmes which will be fed into the computer in order to speed up the matching of analytical results with recommendations for nutrition. The automatic dispensation of nutrition advice for soil-grown cucumber crops is the first result of this work.

Department of physiology

The CC_2 status in glasshouses and its effect on yields has been an important subject for investigation. The CO_2 levels in glasshouses on some twenty commercial nurseries were monitored and recorded over a large part of the season. Some surprising results emerged from this work. During periods when the heating is not or hardly used and no CO_2 is being generated from combustion gases, the CO_2 levels in the glasshouses are often much too low. In CO_2 experiments carried out in the climate glasshouse, the possibly harmful effects of excessively high CO_2 levels were investigated. For various crops grown in winter, a top value of 1,000 ppm CO_2 was established.
Work on the application of growth substances for the promotion of fruit set in eggplants was rounded off. Other application possibilities have not yielded any results yet.
Investigations into the relationship between light and growth, carried out in a specially constructed installation are well on the way. Both shading treatments and treatments with supplementary lighting were examined for their effect on the growth rate.

Department of horticulture and glasshouse climate

Insight into the reaction between light and crop yields was increased. For practical use, the rule that 1 % less light gives a 1 % yield reduction appears to be more or less correct. Yield differences as a result of the light factor were particularly noticeable in spring and during periods of low light levels in summer. During these periods it is also essential to ensure good light transmission in the glasshouses.
Research into energy-saving measures, requiring a great deal of effort, included numerous aspects such as gable insulation, the use of thermal screens and various aspects of the control of the glasshouse climate.

In the latter area, ventilation was given special attention. More information was obtained on the operational characteristics of glasshouse ventilators which will make it possible to obtain more accurate control over the air exchange in glasshouses in future. This is important not only for the vacation of excess heat and moisture from the glasshouse, but also for maintaining adequate CO_2 levels in the glasshouse.
Research was also carried out into the possibilities of growing in nutrient film or on rockwool those crops which hitherto have been regarded as unsuitable for substrate growing. These crops included lettuce, paksoi, kohlrabi and runner beans. If these crops can be grown on substrates, it would make it possible to maintain traditional crop rotation programmes with other crops which are already being grown on rockwool. The production of lettuce in nutrient film certainly looks promising.
A great deal of emphasis was placed on the improvement of the internal quality of produce and this work is being carried out in close cooperation with the department for soils and nutrition. Changes in growing methods and the application of energy-saving measures are the main reasons for this research.

Department of economics and management

The provision of guidance in the development of business recordings received much attention. There was very close cooperation with the industry in this work. The first eight business computers were installed on eight nurseries by the end of the year and they will be used to make a start on very important development in improving the level of business management.
Economic and labour aspects were also investigated. Two projects connected with the economic aspects were an examination of the yield levels obtained on nurseries with substrate crops and an investigation into the possibilities of extending the plant raising periods for a number of vegetable crops grown on substrates. Investigations into labour requirements were carried out in cucumbers and gerberas.

Department of pests and diseases

As a result of the problems encountered in the use of methylbromide as a soil disinfestant, much effort has gone in recent years into improving the efficiency of steam sterilisation methods and particularly steam sterilisation with negative pressure. This work has now reached its final stages. Various spraying techniques have come under scrutiny as part of the effort to reduce the use of chemical pesticides. Although in most cases there are no indications that the amount of chemical applied per unit area can be drastically reduced, it may be possible to achieve some positive results with a combination of certain spraying techniques and special formulations of chemicals.
For many years now, research has been carried out into the control of Mycosphaerella in cucumber, a fungus which is particularly damaging to the quality of the fruit.

The investigations at present are concentrated mainly on internal fruit rot and on the effect of the climate on the incidence of the disease. As part of the development of biological pest control methods, two predatory mites of thrips were introduced on a limited scale on commercial nurseries. Good results were obtained both in sweet pepper and in cucumber. Natural enemies are also used on a modest scale in the control of aphids in sweet pepper.
A virus disease which is new for Holland, i.e. courgette yellow mosaic virus, occurrred in cucumber and courgette crops.
Finally, mention should be made of the fact that both in rockwoll and NFT crops, several pesticides were tested for phytotoxicity, the pattern of the concentrations in the nutrient solution and possible residues in the produce harvested.

PERSONNEL AND FACILITIES

The financial means are becoming more limited and this is being felt in research, forcing us to strive for greater efficiency. Closer cooperation is being sought with sister research stations and in particular with the research stations at Aalsmeer (flower growing) and at Lisse (flower bulbs). Efficiency in research work is also promoted by the provision of good housing facilities. At present this is still poor and preparatory work is being carried out to improve the research buildings.
Intensive efforts are also being made to come to a fifty-fifty basis for financing research work, i.e. 50 % of the necessary funds to be provided by the state and 50 % by the industry.
An impending reorganisation of the routine soil analytical work received much interest. More than 50,000 samples are being analysed annually for growers and it is planned that this work could be shared with a privately owned laboratory at Oosterbeek.
The number of staff employed by the station remained practically the same.
Dr Weststeijn joined the station as deputy director on 1 June.
The facilities were extended by the construction of a glasshouse for research into the applications of low value heat, i.e. residual or waste heat. This glasshouse which was almost completed by the end of the year under review, consists of eight compartments of about 250 m^2 each. The heating system consists of 16 narrow-bore heating pipes per bay, providing a large heat exchange area. This is necessary since the water temperatures are no higher than 40^{o} C. Soil heating and double thermal screens have also been installed. The completion of these facilities will make a further expansion of energy saving research possible.
Much effort is also going into further automation of various aspects of research work such as process control systems (glasshouse climate controls), administrative activities, automation of crop nutrition recommendations, recording and processing of research results, organisation of the library, automation of advisory systems, etc. The necessary equipment is being adapted and programmed for the various purposes.

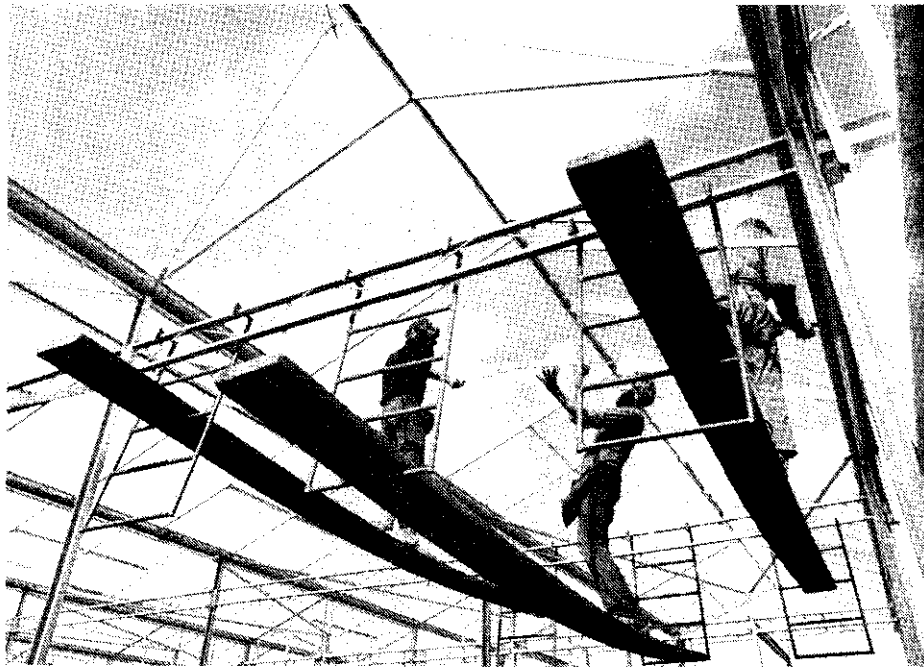

Fig. 1. Construction of the glasshouse for research into applications of low value heat

4. DEPARTMENT OF SOILS, WATER AND NUTRITION

J. van den Ende

WATER RELATIONSHIPS IN GLASSHOUSE CROPS (*R. de Graaf*)

Research into the transpiration of glasshouse crops was continued with an investigation into the effects of thermal screening during the night on the transpiration of tomatoes. The transpiration studies were carried out in the same way as in previous years (see Annual Report 1976, p. 18).
The tomatoes were grown in three separate glasshouse compartments. Each compartment was equipped with a balance with which the transpiration of plants growing in troughs was recorded. The following treatments were applied:

compartment 1 : thermal screens closed during the night between 5 p.m. and 8 a.m. (later on between 6 p.m. and 7 a.m.)
compartment 2 : thermal screens closed during the night in alternate weeks
compartment 3 : no thermal screen applied

The thermal screens were used during the night from the beginning of the crop, 21 December 1982, until 6 March 1983. The transpiration measurements were continued after this date without making comparisons between the compartments. The data recorded until 1 May are discussed.
The thermal screens consisted of a mobile transparent plastic film.
Data on the total transpiration and the average transpiration per day, per night and per 24 hours are shown in the Table below. The relative differences in transpiration during the night are to a large extent the result of using the thermal screens. However, some of the differences may have been caused also by other, coincidental, factors like the plant material, differences in the glasshouse climate and the nutrient status of the growing medium (peat).
It may be assumed that coincidental factors were also responsible for the relatively small differences in transpiration during the periods of daylight. To what extent other factors had an effect on the transpiration differences cannot be determined at this stage, partly because the experiment was carried out without replicates.
That the transpiration differences measured during the night were caused mainly by the application of the thermal screens may be concluded by comparing the nightly transpiration patterns of the three compartments. These aspects are shown in Figure 2.

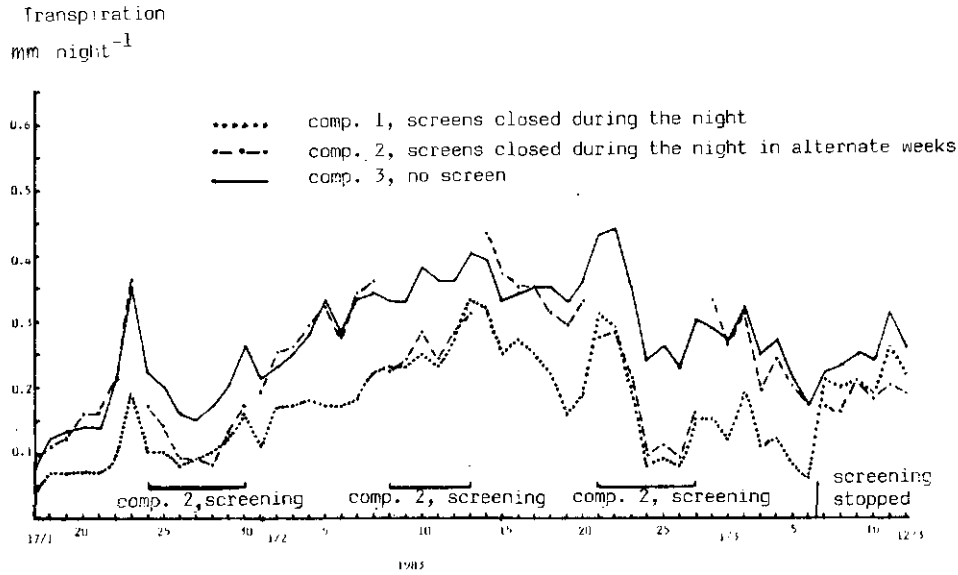

Fig. 2. Survey of the course of transpiration in mm per night.

During the weekly periods when the thermal screens were used, the transpiration pattern of the plants in compartment 2 was about the same as that of the plants in compartment 1 and during the periods when the screens were not used, the pattern was about the same as that of the plants in compartment 3. When the use of the screens was discontinued, the relative differences became very small. This led to the conclusion that the transpiration differences during the night were caused to a very large extent by the use or omission of the thermal screens.

A comparison of the compartments and the periods in which the screens were applied or omitted shows that the average differences in transpiration gradually became larger in the course of the growing period, but that the increase and decrease in the absolute transpiration level were a good deal greater. It follows that the percentage reduction of the transpiration by the application of the thermal screens depends very much on the transpiration level. For instance, the reduction in the transpiration was about 25 % when the screens were used during the nights when the transpiration was relatively great, but it was 60 % when the transpiration was relatively low. Figure 3 shows this for the whole recording period.

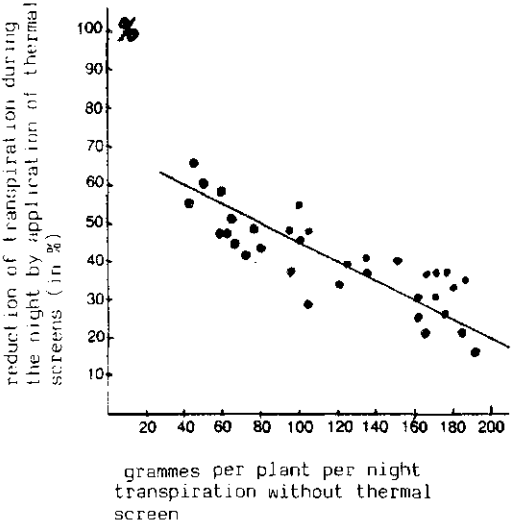

Fig. 3. Effect of thermal screen on transpiration with different transpiration levels.

As in previous transpiration research, a reliable linear relationship between daily transpiration and overall radiation was also established in this case for a given plant size.

Table 1. Data on the total transpiration and the averages per day, per night and per 24 hours.

	23/12 - 6/3						23/12 - 1/5						night in % per 24 hrs.		
Balance	mm						mm								
Comp.	tot. day	av. day	tot. night	av. night	tot. 24h	av. 24h	tot. day	av. day	tot. night	av. night	tot. 24h	av. 24h	6/3	1/5	
1	21.9	0.30	8.7	0.12	30.6	0.41	82.1	0.63	19.6	0.15	101.7	0.78	28.4	19.2	+ scree
2	25.6	0.35	12.9	0.17	38.5	0.52	81.6	0.63	22.0	0.17	103.6	0.80	33.5	21.2	± scree
3	26.5	0.36	15.5	0.21	42.0	0.57	88.2	0.68	27.7	0.21	115.9	0.89	36.9	23.9	- scree

WATER AND MINERAL RELATIONSHIPS IN GLASSHOUSE NURSERIES

(Ph. Hamaker and A.M.M. van der Burg)

The data collected in an experiment carried out in 1982 on the water and nutrient usage of tomatoes, cucumbers and sweet peppers growing in substrate, were processed and incorporated in a report.
The water usage varied between 630 and 1300 mm per annum. The fertiliser usage was correlated with the water usage, varying between 7.5 and 21 tons per ha. An investigation into the leaching of pesticides, carried out in cooperation with the IOB and RIKILT, was completed as far as crops in soil are concerned. Pesticides such as methomyl, oxamyl and a number of organo-phosphorous compounds, could not be traced in the drainage water, or only in very low concentrations. Oxidation products of aldicarp were found quite frequently in the drainage water following application of this chemical. However, besides the oxidation products mentioned, clearly measurable concentrations of methomyl, oxamyl and organo-phosphorous compounds were also found to be present from time to time in the surface water. This indicates that apart from leaching, pesticides also end up in the surface water via other routes.

SOIL TESTING

BROMIDE DETERMINATIONS IN SOIL AND WATER (*P.A. van Dijk, S.S. de Bes and C.W. van Elderen*)

The method for determining bromide by means of the continuous flow analytical method (see Annual Report 1982, p. 13), has now been developed completely. The experiences with the method are positive, both with regard to the analytical procedure and its practical importance for horticulture. The system is reliable and quick. A publication is being prepared.

RESEARCH LABORATORY (*P.A. van Dijk, S.S. de Bes and C.W. van Elderen*)

In support of the routine analytical work for practical horticulture, many samples were again analysed by the research laboratory using many different analytical methods. Since the work was often concerned with elements which are new for the laboratory, the analytical work was usually exploratory in character. Particular attention was given to the analysis of silicon in crops and nutrient solutions, to the determination of total sulphur in crops and to the determination of organic matter in nutrient solutions.
A number of crop samples was analysed for cadmium. As a result of the many cases of boron toxicity found on nurseries, a great deal of time was spent on the determination of this element in all kinds of fertilisers and in particular in fertilisers containing lime.

COMPARISON OF SOIL EXTRACTS (*C. Sonneveld and W. Voogt*)

This year, a start was made on an investigation in which analytical results of the 1:2 volume extract are being compared with the analytical results of the saturation extract and the soil solution. The purpose of the investigation is to determine the relationships between the analytical results of the soil testing method used for practical purposes (1:2 volume extract) and the analytical results of the soil solution.
The work is being carried out with glasshouse soils of various compositions. The results will be processed in the course of 1984.

STATISTICAL PROCESSING OF ANALYTICAL DATA (*L. Spaans and L. van den Bos*)

At present, the necessary information obtained from the forms accompanying all samples is being fed into the computer by the technical administration. A list is compiled and checked every day. The accounts department uses the information for sending out invoices and arranging automatic bank transfers.
The advisory officers are able to check via their terminal whether one of their growers has submitted a sample and they can also obtain the basic data on the soil type, such as organic matter content, pH-KCl, etc. The former is an important point, since it enables growers to obtain advice by telephone very quickly after having sent in a sample.
The analytical results are fed into the computer in series of 20 by the technical administration. The computer calculates the totals of anions and cations and, using a certain formula, the computer also calculates the EC as a check on the EC determined in the analytical process. A system of stars is being used to indicate whether there is sufficient agreement between the calculated and the actual EC values (no star), or whether there are differences in excess of 10 or 20 %. A distinction is made between nutrient solutions on the one hand and soil extracts on the other. Every day, using the data of the soil extracts or the nutrient solutions, the correlations are calculated between the total anions and cations and the EC values, both calculated and determined.
All recommendations, except for those relating to potting compost samples sent in under the R.H.P. compost control system, are still compiled manually, although use is made of 25 standard sentences. This gives some savings in typing the recommendations.
At the end of the year under review, the programme intended for the automation of liquid feeding recommendations for cucumbers on glasshouse soil, was tested. It is expected that this programme will become operational at the beginning of 1984.

CROP ANALYSIS

NITRATE DETERMINATION IN VEGETABLE CROPS (*P.A. van Dijk, S.S. de Bes and C.W. van Elderen*)

Work on the development of a suitable method of preparing fresh vegetable samples for nitrate determinations was continued. In particular, the aim is to develop rapid methods of determination, in line with the practical needs of horticulture. Storage experiments were carried out using fresh produce as well as extracts of crops like spinach, lettuce, radish and chinese cabbage. The following observations were made:

- Fresh vegetables should be extracted within 24 hours because of the changes which take place in the produce such as the formation of NO_3 and NO_2.
- Fresh vegetables may be stored for periods longer than 24 hours in frozen condition only. After thawing out, extraction should also take place within 24 hours.
- Extracts of fresh vegetables should also be analysed within 24 hours because of nitrite formation and the reduction in the nitrate content.

Determinations of the nitrate contents of crops may be carried out by analysing the fresh as well as the dried crop. There appears to be a fairly good correlation between the two methods. Recommendations on nitrate determinations in crops were supplied to vegetable breeding companies and analytical procedures were prescribed for the purpose.

TISSUE TESTS BY MEANS OF PLANT SAP ANALYSIS (*C. Sonneveld and W. Voogt*)

Continued attention was given to comparisons of the results of plant sap analyses with those of analyses based on digestion of dry matter. This year, the comparisons were made with specially raised plant material of tomatoes grown at various potash and calcium levels. Leaves and petioles were dealt with separately. In the dry matter analyses, the potash contents of the leaves ranged between 170 and 1330 $mmol.kg^{-1}$ and between 430 and 3010 $mmol.kg^{-1}$ in the petioles. The calcium contents ranged between 500 and 830 $mmol.kg^{-1}$ in the leaves and between 260 and 980 $mmol.kg^{-1}$ in the petioles. The plant sap analyses produced 85 to 100 % of the potash determined in the dry matter analyses. There was no difference between the percentages for the leaves and the petioles.
In the case of calcium the plant sap analyses produced 25 to 55 % of the contents found in the leaves by dry matter analyses and 5 to 50 % in the petioles. The percentages showed a clear relationship with the level of the contents. They were lowest at the low calcium levels.

SOIL SALINITY

SPECIFIC SALT EFFECTS (*C. Sonneveld and W. Voogt*)

Gerberas were grown this year in the experiments in which specific salt effects are being studied (see Annual Report 1982, p. 17). The crop was started in 1982 and salts were applied in such quantities that the total ion concentrations of the irrigation water were 25 and 50 mmol.l^{-1}. A second experiment was started in 1983 with salt concentrations corresponding to 12.5 and 25 mmol.l^{-1}. Severe specific effects occurred as a result of the application of sodium bicarbonate.
For the crop started in 1982, the results are known for a whole year's growth and for the crop started in 1983, the results for the first six months' growth are known.
The two cultivars used in the experiments, 'Veronica' and 'Appelblossom', showed no differences in salt sensitivity. For ions which do not induce specific salt sensitivity, reductions in flower weight of about 50% at an ion concentration of 25 mmol.l^{-1} and about 65 % at 50 mmol.l^{-1} were found in the first crop started in 1982. The preliminary yield reductions in the 1983 crop were 25 % for 12.5 mmol.l^{-1} and 60 % for 25 mmol.l^{-1}.

NITROGEN SOURCE AND CROP GROWTH (*C. Sonneveld and W. Voogt*)

An experiment was started this year in which various forms of nitrogen were compared. Besides nitrogen as nitrate, treatments were included in which 25 or 50 % of the nitrogen was supplied in the form of ammonia or urea. The effect of applying didin (dicyandiamide) on the nitrification of ammonia was also studied. Two crops of lettuce and one of tomatoes were grown. No significant yield differences were obtained, neither in lettuce nor in tomatoes. In the case of tomatoes, the application of ammonia or urea resulted in less iron chlorosis in the crop in summer. In the case of lettuce, the use of ammonia or urea resulted in lower nitrate and calcium levels in the young leaves.

NUTRITION WITH MACRO ELEMENTS

A NITROGEN FERTILISER EXPERIMENT WITH LILY CV. 'ENCHANTMENT'
(J.P.N.L. Roorda van Eysinga and M.Q. van der Meijs)

A nitrogen fertiliser experiment was carried out this spring in lily cv. 'Enchantment' in a glasshouse block on a commercial nursery on silty marine sand at 's-Gravenzande. The experiment included an unfertilised control, a plot which was given a maximum base dressing of 4 kg N per 100 m^2 before planting and in between, various plots which were given top dressings in different quantities and at different times. In spite of the wide variations in nutrition, no differences in crop development or colour were observed. Flower quality, assessed in vases, did not vary either.

The conclusion was drawn that for lilies a nitrogen level of 2 or 3 mmol N (= NO_3 + NH_4) per litre 1:2 volume extract should be aimed at.

RELATIONSHIP BETWEEN NUTRITION AND CHEMICAL COMPOSITION OR CROP QUALITY

EFFECTS OF NITRIFICATION INHIBITORS ON THE NITRATE CONTENT OF LETTUCE

(J.P.N.L. Roorda van Eysinga, D. Theune and M.Q. van der Meijs)

In two very simple experiments on commercial nurseries, 'Dwell' was mixed with sulphate of ammonia applied to lettuce. 'Dwell' is etridiazole in an organic solvent. The results were promising and the experiments with etridiazole will be continued, but in another formulation, i.e. AAterra, a product available on the market as a fungicide.

NITROGEN FERTILISER EXPERIMENTS IN SPINACH DURING THE WINTER SEASON 1982/83 (*J.P.N.L. Roorda van Eysinga, M.Q. van der Meijs and D. Theune*)

Four nitrogen fertiliser experiments were carried out, the results of which have already been published. The main conclusion reached was that it is difficult to produce spinach during the months of December and January containing less than 4,000 mg NO_3 per kg fresh produce, the standard imposed by the Dutch government. Contents lower than 4,000 mg NO_3 could only be achieved, but without any certainty, if N levels in the soil were low which was accompanied by severe reductions in yields. The use of dicyndiamide (DCD) resulted in a reduction in the nitrate contents of the crop, but also in the yields. It seems likely that it makes little difference whether one omits nitrogen entirely or applies sulphate of ammonia mixed with DCD.

NITROGEN EXPERIMENTS IN LETTUCE (*J.P.N.L. Roorda van Eysinga, M.Q. van der Meijs, D. Theune and L. Spaans*)

A total of eleven fertiliser experiments were carried out in glasshouse lettuce on commercial nurseries in the past few years. All the experimental plots included treatments of 0, 2.5, 5, 7.5 and 10 kg calcium ammonium nitrate per 100 m^2, in four replicates. Six of the plots produced statistically significant effects on the yields. Initially, the soil of these plots had nitrogen contents ranging between 0.5 and 2 mmol N (NH_4 + NO_3) per litre 1:2 volume extract. The plots which did not show a significant response had N contents ranging between 1 and 5 mmol N per litre extract. This means that when the nitrogen content of the soil is between 1 and 2 mmol N, it is difficult to predict whether fertiliser dressings are necessary or not. At low N levels, a dressing of 7.5 kg calcium ammonium nitrate was optimal, whilst the difference obtained with a 5 kg dressing was slight.

The effects on the nitrate contents of the lettuce was statistically significant on quite a number of experimental plots. Lettuce grown under low light intensities contained more nitrate than lettuce grown under good light conditions. There was an interaction between radiation and the response to nitrogen dressings. Under relatively good light conditions, the nitrate contents in lettuce showed a sharper increase following higher nitrogen dressings than under poor light conditions. However, the nitrate levels remained well below those which have been found under low winter light conditions, even in cases where no nitrogen dressings had been applied.
Bromide contents in lettuce were also determined in later experiments. It appears that there is also an interaction in this respect. There is no effect on the bromide contents of lettuce if the bromide levels in the soil and the crop are low, but there is a reducing effect of the nitrogen dressing on the bromide content in the crop if there is a certain amount of bromide present in the soil.

EXPERIMENT WITH UREAFORM IN LETTUCE (*J.F.M.I. Roorda van Eysinga, M.Q. van der Meijs and D. Theune*)

The purpose of this experiment was to determine whether the slow release fertiliser ureaform (38 % N) has a reducing effect on the nitrate contents of lettuce. The experiment was carried out on a commercial glasshouse nursery on a loamy soil (17% silt). The initial soil samples showed only modest nitrogen levels, i.e. 0.1 mmol NH_4 and 2.1 mmol NO_3 per litre extract. Four different amounts of ureaform (0 to 8 kg per 100 m^2) were compared with four rates (0 to 10 kg per 100 m^2) calcium ammonium nitrate (26 % N). The crop was harvested on 21 March when it was found that nitrogen significantly increased the yields. On the untreated control plots, the lettuce harvested weighed 18 kg per 100 heads against 21 kg on the plots with the highest nitrogen dressings. There was no significant difference between the two fertilisers. The nitrate contents ranged from 3100 mg NO_3 on the control plot to 3800 mg NO_3 per kg fresh produce at the highest nitrogen levels. Here also there was a significant effect of the amount of nitrogen applied, but not of the type of fertiliser.
The conclusion must be that compared with calcium ammonium nitrate, ureaform used on lettuce under glass neither increases nor decreases the nitrate contents of the produce. Nor were there any significant differences in yields, other than a positive response to nitrogen dressings.

GROWING SPINACH ON GRAVEL (*M.Q. van der Meijs*)

During the year under review, four crops of spinach were grown on a 2 cm layer of gravel (2 to 4 mm sieve fraction) in plastic troughs. A nutrient solution was circulated through the troughs several times per day.
The aim was to produce spinach with low nitrate contents by omitting nitrogen from the nutrient solution during the final stage of the crop before harvesting.

Good results were obtained with this method in earlier experiments with radish, but spinach still posed problems. An improvement was obtained this year by using a different method of sowing. The chitted seed was sown at some depth in the gravel by covering the seed with a thin layer of gravel. This caused a little more work, but the crop results were good. With regard to the nitrate contents, not all data were available as yet by the end of the year.

SURVEY OF THE NITRATE AND BROMIDE CONTENTS OF VARIOUS VEGETABLES (*D.Theune*)

This investigation was concerned with material obtained from cultivar trials for which the bromide as well as the nitrate contents were determined. In addition, and in cooperation with the Central Bureau of Horticultural Auctions, data were collected on the pattern of the nitrate contents in lettuce and radish in the course of the year. The bromide contents were also determined in this case. Processing of the mass of material collected has not yet been completed. However, some striking results have already emerged.

The relationship between the nitrate contents of lettuce and the average monthly radiation appears to have a different pattern in the first half of the year than in the second half. In the case of lettuce and radish, an interaction was found between the nitrogen level in the soil and radiation on the nitrate content in the crop. The radish material was particularly suitable for an investigation into which ten day period (10, 20 or 30 days) before harvest was the most decisive for the nitrate content in the crop. It was found that this period is longer during the dark season than in summer, since the rate of growth is faster under better light conditions resulting in a shorter growing period. Attention was also given to the interaction between nitrate and bromide contents of the crop.

CO_2 ENRICHMENT AND THE NITRATE CONTENTS OF SPINACH
(*J.P.N.L. Roorda van Eysinga and M.Q. van der Meijs*)

Spinach was grown in plastic cages at various CO_2 levels during the winter months for harvesting in mid-February. The yield increase resulting from CO_2 enrichment was only 2 % and was not statistically significant. No effects of CO_2 enrichment on the nitrate contents of the crop could be found (average 4450 mg NO_3 per kg fresh produce).

GROWING SUBSTRATES

PEAT AS A SUBSTRATE FOR TOMATO GROWING (*G.A. Boertje*)

An investigation was carried out in a tomato crop to determine whether the composition and the quantity of the substrate had an effect on the yields and fruit quality. The following experiment was set up:

Substrate composition	Litres substrate per 2 plants
2 growing boards, 15 x 50 cm	12
2 growing boards, 20 x 50 cm	18
growing bag, 50 % peatmoss - 50 % perlite	18
growing bag, 50 % peatmoss - 50 % perlite	24
growing bag, 1/3 frosted blackpeat, 1/3 peatmoss, 1/3 styromull	24
growing bag, 1/3 peatmoss, 1/3 blackpeat fibre, 1/3 peatmoss coarse grade	24

Tomatoes of the cultivar 'Abunda' were sown on 10 December 1982. A fortnight later, the seedlings were potted up in almost bottomless plastic pots. The plants were placed on the substrate on 24 February. Water and liquid feeds were applied via a trickle irrigation installation. The first fruits were picked on 13 April and the experiment was terminated on 9 September. The results are shown below.

Table 2. Tomatoes on substrates.

Substrate	liters substrate per 2 plants	yields in kg/plant	average fruit weight in g	% fruit with blossom end rot
growing boards, 15 x 50	12	12.2	70.5	8.0
growing boards, 20 x 50	18	11.9	73.9	2.5
growing bag, ½ pm, ½ pl	18	12.0	73.2	3.2
growing bag, ½ pm, ½ pl	24	12.9	75.0	3.1
growing bag, 1/3 fbp, 1/3 ppm 1/3 stm	24	12.2	73.9	3.2
growing bag, 1/3 pm, 1/3 bp fibre, 1/3 pm c.gr	24	13.0	74.7	1.7

The mixture of 1/3 peatmoss, 1/3 blackpeat fibre and 1/3 peatmoss coarse grade used in a quantity of 24 litres compost per two plants gave the best results in this experiment. The kg yield was relatively high and the percentage blossom end rot was low. The kg yield obtained from the 24 litres growing bag, containing the peatmoss and perlite mixture, was also satisfactory.
Cropping on growing boards with 12 litres of substrate available per two plants, resulted in a higher percentage blossom end rot. The increase in the substrate quantity to 18 litres per two plants gave a considerable reduction in the blossom end rot percentage.

ZINC APPLICATIONS FOR TOMATOES IN ROCKWOOL *(W. Voogt and C. Sonneveld)*

In an experiment with tomatoes in rockwool, different quantities of zinc in the nutrient solutions were compared. The zinc contents in the nutrient solutions ranged between 2.5 and 25 $\mu mol.l^{-1}$. At the lowest concentration, the crop showed severe zinc deficiency symptoms and the yield was affected adversely. No differences were found between the higher concentrations. Even at 25 $\mu mol.l^{-1}$ zinc toxicity did not occur.

Fig. 4. Zn deficiency symptoms in tomato.

COPPER APPLICATIONS FOR TOMATOES IN ROCKWOOL (*W. Voogt and C. Sonneveld*)

In an experiment with tomatoes in rockwool, different copper contents in the nutrient solutions were compared. The copper concentrations ranged between 0.2 and 3.5 $\mu mol.l^{-1}$. No obvious copper dificiency was found in the experiment. At the lowest application rate the yield was only a few percent less than with the other treatments. The difference was not statistically significant. Excess symptoms did not occur either.

SILICON APPLICATIONS FOR CUCUMBERS IN ROCKWOOL (*W. Voogt and C. Sonneveld*)

In an experiment with cucumbers in rockwool, two rates of phosphate and three of silicon in the nutrient solutions were compared. The phosphate concentrations were 0.5 and 1.25 $mmol.l^{-1}$ and the silicon concentrations were 0, 0.5 and 1.0 $mmol.l^{-1}$. At 0.5 mmol $P.l^{-1}$ the yields were nearly 10 % lower than at 1.25 $mmol.l^{-1}$. There was also a slight trend towards a higher yield as a result of silicon applications. However, the differences were small.

CALCIUM APPLICATIONS FOR CARNATIONS IN ROCKWOOL (*W. Voogt and C. Sonneveld*)

Various rates of calcium in the nutrient solutions were compared in carnations in rockwool. The amounts of calcium applied in the nutrient solutions ranged between 1.5 and 5.5 $mmol.l^{-1}$. The highest yields were obtained at 3.5 and 4.5 mmol Ca per litre. Severe calcium deficiency occurred at 1.5 mmol Ca per litre.

ANION RATIOS FOR BEANS IN ROCKWOOL (*W. Voogt and C. Sonneveld*)

Different anion ratios were compared in the nutrient solutions used for runner beans grown in rockwool. NO_3 concentrations ranged from 7 to 13 $mmol.l^{-1}$, phosphate from 0.75 to 1.25 mmol and sulphate from 0.5 to 3.5 mmol. There were no differences in yields, but there was some yellowing of the crop at the lowest nitrogen level.

CATION RATIOS FOR TOMATOES IN SOILLESS CULTURE (*W. Voogt and C. Sonneveld*)

Various potash, calcium and magnesium ratios were compared in fleshy tomatoes grown in a system with recirculating nutrient solutions. The cation ratios in the nutrient solutions and the yields are shown in the Table below.

Table 3. Cation ratios, yields of fleshy tomatoes and the percentages of blossom end rot (BER) and blotchy ripening (BR).

Ratios applied			kg per m^2	BER %	BR %
K	Ca	Mg			
3.0	6.5	1.2	8.4	0.1	11.8
5.5	5.2	1.2	9.6	1.5	5.0
8.0	4.0	1.2	11.5	2.2	4.4
2.7	5.8	2.0	8.1	0.1	11.1
5.0	4.8	2.0	9.8	1.9	6.1
7.2	3.6	2.0	11.5	2.7	5.4

There was some potash deficiency in the experiment, particularly in the treatme with the lowest potash levels. This had a decidedly adverse effect on the yields. Blossom end rot was encouraged by high potash levels which discouraged blotchy ripening. High potash levels also improved the keeping quality of the fruit and produced a higher perc tage organic acids in the fruit.

EC VALUE FOR STRAWBERRIES (*W. Voogt and C. Sonneveld*)

A range of EC values of the nutrient solutions in the root environment was tried in an experiment with strawberries grown in polyphenol foam. The EC values ranged between 0.5 and 6.0 $mS.cm^{-1}$ at 25^{o} C. The highest yields were obtained at 2 $mS.cm^{-1}$ and at 6 $mS.cm^{-1}$ the yields were about 30 % lower. Significantly lower organic acid and sugar contents of the fruit were also found at low EC value.

APPLICATION OF HUMIC COMPOUNDS FOR CUCUMBERS GROWN IN ROCKWOOL (*C. Sonneveld and W. Voogt*)

In an experiment with cucumbers in rockwool, humic compounds were added to the nutrient solutions. The compounds were extracted from farmyard manure and from different types of peat. On the whole, the effects of humic compounds on the yields were negative. In one of the treatments the yields were reduced by nearly 40 %. There were also significant differences in the nutrient element contents of the leaves. The application of humic compounds resulted in lower potash and higher calcium contents in the leaves.

PLANT NUTRITION AND GLASSHOUSE CLIMATE

EXPERIMENTS IN THE ENERGY GLASSHOUSE (*Y.W. Aalbersberg and C. Sonneveld*)

Tomatoes and cucumbers were grown in rockwool in the energy glasshouse this year (see Annual Report 1982, p. 27).

In tomatoes, particular attention was given to the effects of high EC values of the nutrient solutions in the root environment during the initial stages of the crop in the months of December and January. Initially, the EC values in the root environment were regulated to levels between 2 and 15 $mS.cm^{-1}$ which were adjusted to 2.5 $mS.cm^{-1}$ at the end of January.

By the end of January, the differences in the condition of the plants were considerable. Higher EC values produced darker coloured plants with a high dry matter content. The differences were more pronounced under single than under double glass. However, in spite of the wide variations in plant conditions as a result of the different EC values, the yield differences were only small. The lower EC level introduced at the end of January, very quickly evened out the differences.

By the end of March, there were wide variations in the degree of magnesium deficiency in the crop which increased sharply according to the EC value maintained in the initial stage of the crop. This was found to be the result of a low magnesium uptake during the period of high EC values. An increase of 5 or 6^{0} C in the temperature in the root environment was found to reduce severe magnesium deficiency.

In cucumbers, comparisons were made between four nutrient solutions with different calcium levels applied in three concentrations. A calcium level of 1.5 mmol per litre nutrient solution produced calcium deficiency in the leaves which practically disappeared at a level of 2.5 mmol Ca. At low calcium leaves, the leaves of the primary laterals also showed chlorotic symptoms.

The highest yields were obtained at 2.5 to 3.5 mmol Ca per litre nutrient solution. With regard to the EC value, the highest yields were obtained at 2.0 $mS.cm^{-1}$. At 4.0 and 6.0 $mS.cm^{-1}$, the yields were reduced by 20 and 31 % respectively.

EC VALUES FOR CUCUMBERS (*Y.W. Aalbersberg and C. Sonneveld*)

Different EC values were maintained in the nutrient solution in the root environment of a cucumber crop grown in rockwool. The lowest value was 1.5 and the highest 7.0 $mS.cm^{-1}$. The yields showed a more or less linear reduction with increasing EC levels, equivalent to about 5.6 % per unit. However, fruit quality was better at higher EC values.

MAGNESIUM DEFICIENCY IN TOMATOES (*Y.W. Aalbersberg and C. Sonneveld*)

The incidence of magnesium deficiency and its relationship with the cation ratios were studied in an experiment with tomatoes in rockwool. Table 4 shows the different treatments, the degree of magnesium deficiency in the leaves, the yields and the incidence of blossom end rot.

Table 4. Magnesium deficiency, yields and blossom end rot (BER) in tomatoes and the relationship with the cation ratios in the nutrient solution.

K	Ca	Mg	Mg deficiency* 22-9	14-11	kg per m^2	BER number per m^2
9.0	2.5	1.0	0.2	3.2	13.0	14
7.0	3.5	1.0	0.8	3.8	13.3	4
5.0	4.5	1.0	0.0	2,6	11.4	2
7.3	3.65	0.7	2.2	4.0	10.4	5
7.0	3.5	1.0	0.8	3.8	13.3	4
6.7	3.35	1.3	0.0	1.6	12.5	7

The K/Ca ratio did not have much effect on the incidence of magnesium deficiency, but the magnesium content did.
The yields are adversely affected by low potash as well as low magnesium conter
Apparently, magnesium deficiency affects the yields only if it occurs in the early stages of the crop.

NITROGEN AND POTASH NUTRITION OF AMARYLLIS OR HIPPEASTRUM

(J.P.N.L. Roorda van Eysinga, M.Q. van der Meijs and D. Theune)

During the year under review, Amaryllis bulbs were grown on the long term nitrogen and potash experimental plots under glass at the Naaldwijk Research Station. The existing N and K levels in the experimental plots are maintained by the application of top-dressings based on regular soil analyses. In March the levels were corrected by dressing the N plots with 0, 2, 4 and 8 kg calcium ammonium nitrate per 100 m^2 and the K plots with 0, 2, 4 and 8 kg sulphate of potash. In addition, fertilisers containing other elements were applied to all the plots. The bulbs were planted in mid-April in three beds per glasshouse bay and a different cultivar in each bed, i.e. 'Apple Blossom' (AB), 'Red Lion' (RL) and 'Orange Souvereign' (OS).
The development of the crop was excellent, except on the 0 N and 0 K plots in which the crop was obviously retarded, with the plants in the 0 K plots showing no symptoms and those in the 0 N plots showing a pale colour.
For some unknown reason, probably a faulty irrigation valve, the crop was given too much water at the end of July which caused a reduction in the nitrogen and potassium levels in the soil. At the beginning of August, a topdressing was applied to the crop and watered in well. Apart from other elements, 0, 2, 4 and 8 kg calcium nitrate was applied to the N plots and the same dressing was repeated two days later. The K plots were dressed with 0, 3/4, 1½ and 3 kg sulphate of potash per 100 m^2 and the treatment was repeated at the end of August.
On average, the following contents were recorded in the soil extract over the whole growing season (excluding the low figures obtained at the end of July).

	NH_4	NO_3	N mmol/l		K mmol/l
N 0	0.1	0.4	0.5	K 0	0.1
N 2	0.1	1.6	1.7	K 1	0.3
N 4	0.1	3.5	3.6	K 2	1.3
N 8	0.1	9.5	9.6	K 4	4.0

During the first week in November, 21 bulbs were harvested from each plot (five replicates) and the weights of the foliage and the bulbs with the roots were determined. Two of the bulbs in each batch were also weighed without the roots and the flower bud formation was checked.

Table 5. Weights of Amaryllis foliage and bulbs plus roots from the long term N and K plots (average of 5 x 21 plants).

Foliage (g per plant)

	N 0	N 2	N 4	N 8		
AB	131	190	233	235	lin. $P < 0.01$	quadr. $P < 0.01$
RL	324	542	551	552	lin. $P < 0.01$	quadr. $P < 0.01$
OS	410	579	651	530		quadr. $P < 0.01$
	K 0	K 1	K 2	K 4		
AB	114	189	272	277	lin. $P < 0.01$	quadr. $P < 0.01$
RL	304	558	568	567	lin. $P < 0.01$	quadr. $P < 0.01$
OS	229	580	589	644	lin. $P < 0.01$	quadr. $P < 0.01$

Bulbs plus roots (g per plant)

	N 0	N 2	N 4	N 8		
AB	327	352	382	355		quadr. $P = 0.02$
RL	356	402	380	392	n.s.	
OS	450	451	466	394	n.s.	
	K 0	K 1	K 2	K 4		
AB	343	379	371	362		quadr. $P = 0.04$
RL	363	399	406	357		quadr. $P < 0.01$
OS	377	473	461	445	lin. $P < 0.01$	quadr. $P < 0.01$

The foliage showed a greater response than the bulbs plus the root system. The interesting point in this is that the highest K level (K 4) gave on average a higher yield in leaves than the second highest level (K 2). It should be noted that the K 4 level is a high one even for a crop like tomatoes.

The K 0 plots produced on average only half the weight of the foliage produced by the K4 plots. In examining the yield figures for the foliage at higher N levels the conclusion could be drawn that 'Orange Souvereign' is more sensitive to excess nitrogen than 'Apple Blossom' or 'Red Lion'.

For the bulbs plus the roots - the parts of the crop which really matter - the optimum levels are lower than for the foliage. For nitrogen N 2 and N 4 were the best treatments and for potash K 1 and K 2.

The fact that the bulbs plus roots do not give a clear picture is caused partly by the roots. The weight of the roots (700 to 100 g per plant) tends to obscure the differences in bulb size.

In the flower bud assessments only very modest differences were found. There was only a slight difference in the flower bud length of flower 3 and a somewhat more marked difference in flower 4.

Summarizing, it is suggested that for the production of Amaryllis bulbs nitrogen levels of 3 to 4 mmol N (NH_4 + NO_3) per litre 1:2 volume extract and potash levels of 1 to 1½ mmol K should be maintained, which is in line with the nutritional requirements of many other less demanding crops.

CHRYSANTHEMUM STOCKPLANTS IN RECIRCULATING NUTRIENT SOLUTIONS WITH DIFFERENT EC LEVELS (*M.Q. van der Meiss*)

In order to study the quality of chrysanthemum cuttings, stockplants were grown in recirculating nutrient solutions at various EC levels. Two experiments were conducted, the first one was started on 9 February with the cultivars 'Milonka' and 'Cassa' and the second one was started on 21 July with the cultivars 'Regoltime' and 'Cassa'. EC levels of 3/4, 1½, 3 and 6 $mS.cm^{-2}$ (at 25° C) were maintained in the nutrient solutions by the addition of more or less concentrated stock solutions (A and B). The method produced a good crop in all the treatments, be it that there was some variation in the colour of the crop. At the highest EC level the plants were dark green and at the lowest EC level they were lighter green. Temporary iron deficiency appeared at the two lowest Ec levels in the initial stages of the spring crop, but following the application of some extra iron chelate it disappeared again. Cuttings were collected from the first

crop between 28 February and 26 May when the experiment was terminated. In the second crop, the cuttings were collected between 5 August and 9 November. In neither of the two crops, nor in any of the cultivars, were the yields - measured in numbers of cuttings produced - significantly affected by the treatments. However, there was an effect on the weight of the cuttings and particularly the average cutting weight was found to be dependent on the EC level.

Table 6. Weight in g per cutting as a result of the EC level of the nutrient solution.

EC	3/4	1½	3	6	$mS.cm^{-1}$
spring crop					
'Milonka'	1.26	1.46	1.47	1.39	quadr. $P < 0.01$
'Cassa'	1.70	1.82	1.83	1.71	n.s.
autumn crop					
'Regoltime'	0.92	0.86	0.86	0.76	lin. $P < 0.01$
'Cassa'	0.81	0.79	0.75	0.70	lin. $P < 0.01$

On a few occasions, the quality of the cuttings was assessed by examining the root formation, the development of the cuttings and other aspects. The assessments were carried out by a chrysanthemum propagation company. No significant effect of the EC on the quality could be established.
In the second crop, part of the material was also used for inoculation experiments with Erwinia carotovora subsp.carotovora. There was a very weak trend for the disease incidence to be slightly less severe at the high EC level.
This effect could be explained by the higher percentage of dry matter produced at this EC level. It was found that the EC had an effect on the dry matter percentage. In the spring crop, an average dry matter content of 11.1 % was found in both cultivars at the highest EC level, against an average of 10.7 % at the other EC level.
In the autumn crop, a statistically significant effect was found in both cultivars with the regression equation (averaged over both cultivars):

$y = 0.311\ x + 9.29$, in which x = EC in $mS.cm^{-1}$ and y = percentage dry matter.

The conclusion to be drawn from these experiments is that the concentration of the nutrient solution has little or no effect on chrysanthemum stockplants. It appears that the number of cuttings is not affected at all by this and that the weight of the cuttings is slightly reduced with a lower percentage dry matter. Disease susceptibility is perhaps slightly less with increased dry matter, but further research into this aspect is necessary.

5. DEPARTMENT OF PHYSIOLOGY

P.J.A.L. de Lint

THE EFFECTS OF ENVIRONMENTAL FACTORS ON GROWTH AND DEVELOPMENT OF GLASS-HOUSE CROPS

EFFECTS OF LIGHT INTERCEPTION AND SUPPLEMENTARY LIGHT ON THE GROWTH AND DEVELOPMENT OF YOUNG TOMATO PLANTS (*S.A. Toozé*)

From March to December 1983, a series of light interception and supplementation experiments was carried out. Upon emergence, tomato plants (Lycopersicon esculentum cv. 'Bellina') were placed under either shading material or supplementary lighting.

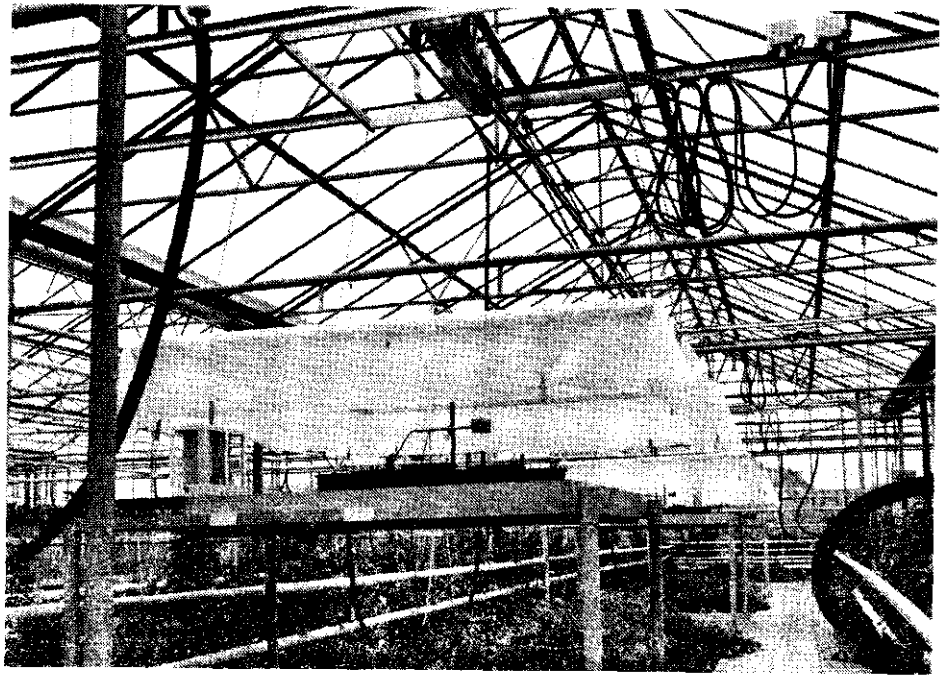

Fig. 5. A view of the shading installation for light interception research.

In spring and autumn, netting was used in layers which reduced the incoming light by 4, 8 and 19 % compared with the control. During the summer months, Agryl p 17 thermal screen was used which resulted in light reductions of 24, 35 and 50 % compared with the control. In March and November, high pressure sodium lamps were used with 1, 2 and 4 lamps per plot which provided 8, 16 and 32 $W.m^{-2}$ respectively.
The shading material was present during the daylight hours only. The lamps were lit from sunset to sunrise in the March experiment and from 5 hours after sunset to sunrise in the November experiment in order to prevent continuous light chlorosis. The experiments continued until the plants reached a fresh weight of 10 g.

Net screen experiments

In March and September , there were no significant differences in the RGR between the shade treatments and the control. The RGR for the control was 0.279 $g.g^{-1}.day^{-1}$ in March and 0.305 $g.g^{-1}.day^{-1}$ in September. The growth periods to 10 g were 22.9 days and 20.5 days in March and September respectively.
The 19 % shade resulted in a growth period which was 2.5 % longer than the control, whilst the leaf development rate remained unaffected. In November, the RGR was 0.178 $g.g^{-1}.day^{-1}$ and the growth periods to 10 g and the 15th leaf were 32.8 and 31.9 days respectively. Only the 19 % shade resulted in a significant difference in the growth periods with an increase of 6.5 %, or 2.2 days. The growth period to the 15th leaf initiation was 10 % longer than in the control.
The leaf area at 10 g fresh weight increased slightly as the percentage shading increased, indicating that the leaves were becoming thinner.

Thermal screen

During the summer months, the average growth periods to 10 g fresh weight and the 15th leaf were 19 and 21 days respectively. The RGR averaged at 0.334 $g.g^{-1}.day^{-1}$.
The growht periods to 10 g fresh weight and the 15th leaf were 6 and 5 % longer respectively for 50 % shade in April. The 24 and 35 % shading gave no significant differences in growth during the summer. In May, June and July, there was little or no difference in the RGR or the leaf initiation rate with 50 % shading.

Supplementary light

In March, 24 hours' lighting resulted in leaf chlorosis especially at the highest light levels. 8 $W.m^{-2}$ resulted in reductions in the growth period to 10 g, by 5% in March and 12 % in November. 32 $W.m^{-2}$ decreased the growth periods by 7 % in March and 25 % in November compared with the control.
The leaf initiation rates were affected similarly. The effect of supplementary lighting is clearly greater in November when the natural radiation is approximately one-fourth that in March. The leaf areas at 10 g fresh weight were 453, 277, 253 and 201 cm^{-2} for the control and for 8, 16 and 32 $W.m^{-2}$ respectively.

It appeared that the leaves increased in thickness as the light levels increased, but this is not conclusive since the specific leaf ratio was not determined. In the summer experiments, 50 % shade resulted in less than a 5 % increase in the growth periods to 10 g. This is an indication that single plants in the first stage of growth become light saturated in summer. The autumn and spring shading and supplementary lighting affected growth and development to a greater extent. The leaf area appeared to decrease with increasing light levels and to increase with shading. This is an indication that single plants are able to compensate for reduced light by producing a thinner leaf with a greater area.

EFFECTS OF LIGHT AND TEMPERATURE ON THE FIRST THREE TRUSSES IN TOMATOES

(D. Klapwijk and C.F.M. Wubben)

In the Annual Report 1982, p. 30 - 32, the results were described of an experiment with tomatoes cv. 'Sonato' sown on 25 October 1981. The plants were raised in a glasshouse under natural light conditions and at relatively high temperatures (DH) or with large amounts of supplementary artificial light combined with low temperatures (SL). The plants were moved from the DH to the SL regime and vice versa on many occasions.
The experiment was repeated on two subsequent occasions using sowings made on 17 December 1981 and on 10 February 1982. The results were largely similar to those obtained in the first experiment. The following conclusions may be drawn:

- under constant DH conditions, the leaf numbers below the first truss in the three experiments were 12.8, 12.0 and 11.0 respectively. Under constant SL conditions the leaf numbers were 7.6, 7.7 and 7.6 respectively.
- when the plants were moved from the DH to the SL regime, the level of first truss initiation became higher the longer the plants stayed in the DH regime. It seems likely that the first two days under DH conditions had no effect. In the three successive experiments, the maximum leaf numbers were recorded at 24, 34 and 16 days after emergence.
- when the plants were moved from the SL to the DH regime, it was found that in the three successive experiments 4, 5 and 1 days respectively under SL conditions did not result in a lowering of the first truss. When the plants were moved after this stage, the number of leaves below the first truss decreased rapidly to a minimum.
- several experiments with similar results have been described in the literature, although the investigations have usually been less complete.
- when the first truss was initiated at a very low level, the transfer from the SL to the DH regime caused a delay in the initiation of the second and even the third truss.
- the fresh weight of the plants was not affected systematically by the treatments.
- when the plants were moved from the DH to the SL regime, it was found in the three experiments that respective periods of 21, 27 and 21 days under DH conditions following emergence, did not have an elongating effect.

- when the plants were moved from the SL to the DH regime, elongation took place very soon after the transfer.
- the data lead to the conclusion that in the three experiments truss induction took place, 10, 16 and 9 days before the stage which the first truss could be indentified under the microscope.
- the results are difficult to apply in commercial plant raising. For the early heated crop, initiation of the first truss at a low level offers no advantage, since the leaf area becomes too small to intercept sufficient light for the development of the truss. For the later crops, the plants would have to remain too long under high light/low temperature conditions, failing which the second and third trusses would be initiated at too high a level.

EFFECTS OF THE SEASON ON THE PRODUCTION RATES OF TOMATOES (*D. Klapwijk*)

Further calculations were made using the data published in the Annual Report 1982, p. 32. It has been reported already that the production rate of tomatoes under glass increases throughout the year from a start until a maximum is reached. The maximum rate is higher in summer than if the harvest begins in spring or autumn. After the maximum has been reached, the rate declines again until it stays more or less constant until the end of the harvest period. The increase in the production rate during the season was calculated. In the earliest crops (first pick in week 13), the yields increased during the initial period by about 0.1 kg per m^2 per week. The increase gradually became larger the later in the season the harvest started. This was also true for harvests starting after the longest day. The maximum increase was 0.6 kg per m^2 per week for harvests starting in week 37.

The decrease in the rate of production after the maximum point had been reached had a completely different pattern during the season. In the earliest crops (first pick in week 13) and also in the latest crop (first pick in week 37), the production rate decreased after the peak had been reached by about 0.04 kg per m^2 week. In mid-summer, the peak was much higher and the subsequent decrease was much greater, i.e. a maximum of 0.18 kg per m^2 per week. The decrease in the production rate after the harvest peak is therefore always much smaller than the increase in the production rate before the harvest peak.

SEASONAL EFFECTS ON THE GROWTH AND FLOWER INITIATION OF SPRAY CARNATIONS (*D. Klapwijk and C.F.M. Wubben*)

The Annual Report 1981, p. 36, contains data collected in a literature survey on the growth periods of perpetual flowering carnations from stopping to flowering. It is interesting to note that none of the research workers has taken the trouble to also record flower initiation.

In order to fill this gap, carnations were planted up at regular intervals throughout the year, starting in September 1982. The plants are used to collect data on growth, flower initiation and flowering of the shoots at fortnightly intervals. Spray carnations are being used since they are economically more important these days and also because much less is known about this type of carnation. Planting will continue until July 1984 and the collection of data will be completed in the spring of 1985.
The slowest and the quickest crops produced the following results: when the plants were stopped on 28 September, the shoots took 5.5 months to reach a fresh weight of 10 g. There were 21 leaf pairs present at that stage and the shoot length was 23 cm. The shoots flowered after about nine months.
Plants stopped on 14 July weighed 10 g after 7 weeks when 17 leaf pairs had been initiated. The shoots were 20 cm long and flowered after little more than three months. The ratio of the different growth rates is therefore about 1:3. The petal numbers varied between a minimum of 33 and a maximum of 43 when the plants were stopped on 1 April and in mid-May.

EFFECTS OF THE SEASON ON THE DEVELOPMENT RATES OF ANTHURIUM ANDREANUM

(*D. Klapwijk and H.J.H. van der Spek*)

The intervals between the first observation of the flower buds and the flower harvests were recorded for five Anthurium andreanum cultivars on a commercial nursery during 1981/82.
For flowers harvested during the period from June until May of the following year, the growth periods per harvest month averaged over the five cultivars, starting with the number of days between first flower bud observation and the harvest in June, were:
49, 46, 48, 53, 62, 75, 74, 65, 58 and 52 days.
Plotted in a graph, these data show that the pre-harvest growth periods are a constant 48 days during the harvest months of June to October. The effects of different radiation levels during this period on the growht periods of the flowers seem to be insignificant. After October, there is a linear increase in the growth periods from 48 to 75 days for the harvest in February, after which the growth periods show a linear decrease again to 48 days for harvests in May. Plotted against the middle dates of the growth periods between first flower bud observation and flowering, the data show that the maximum growth period was recorded for those flowers which have an equal growth period before and after 21 December (i.e. harvest around 1 February - 5.5 weeks before and 5.5 weeks after 21 December).
There were rather wide variations between the cultivars. Over the whole year, the quickest maturing cultivar required 12 days less than the slowest cultivar. However, the quickest cultivar also had the lowest flower yields. The reason for this may be that more of the flower buds abort and/or that new flower buds abort and/or that new flower buds are formed more slowly.

The yield pattern of Anthurium andreanum over the year is quite different from the pattern of the monthly growth periods. The growth periods are constant for the harvest from June to October. However, the flower yields show a linear increase from a minimum around 15 March to a maximum around 30 June, after which they show a linear decrease to 15 March. During the winter, the relationship between flower yields and radiation levels is less clear than it is for the growth periods and the reverse is true for the summer months. This again may be caused by differences in the rates of flower bud initiation and the percentage of developing flower buds. More data will therefore have to be collected in order to gain a better insight into the seasonal effects.

THE EFFECTS OF CO_2 ENRICHMENT ON DRY MATTER PRODUCTION AND DISTRIBUTION IN GLASSHOUSE CROPS

THE EFFECTS OF CO_2 CONCENTRATIONS ON THE GROWTH AND DEVELOPMENT OF YOUNG TOMATO, CUCUMBER AND SWEET PEPPER PLANTS (*D. Klapwijk and C.F M. Wubben*)

From January till June 1983, 5 - 6 sowings of young tomato, cucumber and sweet pepper plants were grown at 225, 744, 1485 and 2700 ppm CO_2. Average night temperature was 21° C and day temperature depended on solar radiation. Ventilators were never opened
For tomato and cucumber the decrease in growing periods has been calculated for the first and second half of the propagation period. Reductions in growing period till 0.5 g fresh weight for tomato were 10, 10, 11 % at 744, 1485 and 2700 ppm CO_2 compared to 225 ppm. For the growing period from 0.5 till 20 g the reductions were 4, 6 and 6 %. For cucumber the reductions till 1 g fresh weight were 15, 21 and 21 % and from 1 g till 20 g 8, 9 and 8 %. The smaller effects on the second period may have resulted from plant adaptation through production of thicker leaves.
For tomato the growing period till 20 g fresh weight during January - March decreased 4, 5 and 7 %, cucumber 7, 10 and 10 % and sweet pepper 6, 7 and 8 %. For April - May these percentages for tomato are 9, 10 and 9 %, cucumber, 13, 16 and 15 % and sweet pepper 10, 15 and 12 %.
Leaf damage caused by pure CO_2 occurred in April and May at both highest concentrations, but nevertheless the carbon dioxide effects of all concentrations on growth were more pronounced at the higher light and temperature conditions in April and May.
CO_2 enrichment also resulted in a difference in plant quality. At 744 ppm the plant weight was increased, by approximately 55 %, but plant height was increased by only approximately 25 %. This means that the plants became heavier per cm height. The rate of leaf initiation was increased by 4 % at most. Since the weight increase was much greater, it follows that the leaves became heavier. No measurements were carried out to determine whether the leaves were larger or thicker. However, other experiments have shown clearly that the leaf responds to CO_2 enrichment with a decrease in the leaf area per gramme which means a thicker leaf. Dry matter content in enriched plants was about 20 % higher as compared to the control.

PHOTOSYNTHESIS OF GERBERA 'MARLEEN' AND 'GOSTA' (*G. Bussen* and N. van Berkel*)

Photosynthesis measurements were carried out on two gerbera cultivars, 'Marleen' and 'Gosta', in cooperation with the Department of Horticulture, Agricultural University, Wageningen.

The leaves of 'Marleen' are readily damaged by high CO_2 concentrations whilst 'Gosta' is not susceptible.

Photosynthesis measurements were carried out on plants which had been grown for some time at CO_2 levels of either 300 to 400 ppm, or 1200 to 1600 ppm, the latter level being damaging to 'Marleen'. The preliminary results indicate that the photosynthesis of 'Marleen' plants grown at 1200 to 1600 ppm CO_2 is retarded compared with that of 'Gosta' plants, whilst plants of both cultivars grown at 300 to 400 ppm CO_2 hardly show any difference in photosynthesis.

It seems that under conditions of high light intensities (200 W per m^2), 'Gosta' has a higher carboxylation efficiency than 'Marleen' within the CO_2 range of 350 to 700 ppm.

EFFECTS OF CO_2 CONCENTRATION ON GROWTH AND PRODUCTION OF GLASSHOUSE VEGETABLE CROPS (*G. Heij*)

From CO_2 recordings carried out on more than 20 nurseries, (see Annual Reports, 1981, p. 38 and 1982, p. 35), it again became evident that CO_2 concentrations dropped below ambient levels on many occasions. In order to determine the optimal rates of CO_2 applications, it is necessary to study the exact production levels of a crop under various CO_2 regimes. For this purpose, six CO_2 concentrations in four replicates were maintained in the 24 compartments of the computer-controlled glasshouse. Two of the concentrations selected were below ambient level, i.e. 150 and 245 ppm. The other four were above ambient level, viz. 430, 790, 1500 and 2870 ppm. The glasshouse was made as airtight as possible and ventilation rates were less than 0.1 per hour.

As far as possible, the ventilators were kept closed from mid-December until at least the end of March. Various crops were grown in the four parallel series of compartments containing the six CO_2 concentrations.

Cucumbers were planted in one series, with two successive plantings and overlapping production periods. Another series was used for two short crops of tomatoes in succession. The third series of compartments was used to observe the growth rates of tomato, cucumber and sweet pepper seedlings. These three crops were sown at frequent intervals over the first six months of the year (see above p.38). In the last series of six compartments three crops were grown together, viz. butterhead lettuce, iceberg lettuce and radish. These were planted four times in succession. However, in the last two plantings, iceberg lettuce was replaced by endive.

The growth and yields of all the crops were recorded at regular intervals to be evaluated against the actual CO_2 levels achieved in the compartments. Each series of compartments had its own temperature setpoints, whilst the ventilation setpoint was 28° C in all compartments.

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The required CO_2 levels were maintained by the opening of a CO_2 release valve or, alternatively, the switching on of a scrubber fan for eight minutes during the intervals between two successive CO_2 checks. CO_2 was supplied from a bulk tank. The scrubber consisted of a two layer bed of soda lime grit through which air was sucked by a fan. In order to avoid simultaneous CO_2 release and scrubbing, the setpoint concentration for scrubbing was selected at 5 % above the CO_2 level required in each compartment. Scrubbing was applied only in the compartments with the two lowest CO_2 levels. The CO_2 levels were controlled during the daytime only, from one hour before sunrise until half an hour before sunset.

The crops were planted out at double density initially. Alternate plants were removed for analyses during the course of the experiment, so that eventually normal spacing was obtained.

The results of this experiment are and will be published for individual crops separately.

INJURY TO TOMATO AND CUCUMBER CAUSED BY HIGH CO_2 CONCENTRATIONS

(N. van Berkel)

It is known already that CO_2 levels in excess of 1200 ppm may cause leaf scorch in gerbera cv. 'Marleen' as a result of decomposition of the chlorophyll granules (Annual Reports, 1980, p. 36-37 and 1982, p. 34-35). When this decomposition becomes advanced, the leaves die resulting in reduced flower yields.

During the year under review, it was found that high concentrations of pure CO_2 may also cause injury to cucumber and tomato. In an experiment, designed to study the effects of six CO_2 levels on the growth of cucumber and tomato (see page), with cucumber no damage was found at a level of 750 ppm. At 1500 ppm, accelerated chlorophyll decomposition took place followed by the death of the older leaves. The damage was even more severe at 2870 ppm. The damage patterns were identical with those found repeatedly around the beginning of March on nurseries using CO_2 generated from the combustion gases of boiler installations. Apparently, CO_2 is the component of the combustion gases which causes the damage. The same pattern is found in tomato. No damage at 750 ppm, some damage at 1500 ppm and severe damage at 2870 ppm as a result of rapid breakdown of the chlorophyll, followed by die back of the leaflets or the entire leaf. Here too, the damage symptoms seen on nurseries using CO_2 from combustion gases during the winter months were identical with the damage caused by pure CO_2. Undoubtedly, CO_2 is the component which causes the damage. It is known that a reduction in the CO_2 content in combustion gases will reduce the damage in cucumber and tomato.

TEMPERATURE AND CO_2 EXPERIMENTS IN CHRYSANTHEMUMS IN THE CLIMATE GLASSHOUSE

(C. Heij, A.P. van der Hoeven and P.J.A.L. de Lint)

During this winter season temperature and CO_2 experiments are being carried out in chrysanthemums in the 24 compartments of the climate glasshouse.

In the temperature experiments carried in the same glasshouse two years ago, the emphasis was on night and day temperatures and on the difference between day and night temperatures. The main aspects being studied this time are the effects of the night temperature during different stages of the crop and the effects of the temmperature during one stage on the growth and flowering during the next stage. The following factors have been incorporated in the experiment: temperature, CO_2, cultivars, plant size and plant density.

The day temperature in all compartments has been set at 17° C for the duration of the crop. The experimental plots have been laid out in three series with night temperatures of 13, 16, 19 and 22° C. In one series the temperature is maintained at a constant level for the duration of the crop. In the second series a night temperature of 18° C is maintained from the beginning of the short day treatment until the end of the crop. In the third series, a night temperature of 18° C is maintained during the flower bud initiation stage only. The following temperature variations are being applied to the different compartments and crop stages:

Table 7. Temperature settings during different stages of development in chrysanthemums.

	vegetative stage	flower bud initiation stage	flower bud development stage
Series 1	13	13	13
	16	16	16
	19	19	19
	22	22	22
Series 2	13	18	18
	16	18	18
	19	18	18
	22	18	18
Series 3	13	18	13
	16	18	16
	19	18	19
	22	18	22

During the whole cropping period, a CO_2 concentration of 300 ppm is being maintained in one set of 12 compartments and 900 ppm in the other set of 12 compartments. The experiment is being carried out with the cultivars 'Spider', 'Horim' and 'Cassa'.

For observation purposes, the borders not included in the experiment are planted up with the cultivars 'Delta', 'Snapper', 'Regoltime', 'Westland', 'Record', 'Clinstar', 'Pink Pompoen' and 'Dark Janancy'.
The three main cultivars were planted on 20 October and 3 November 1983 in order to have available a tall and a lower crop at the beginning of the short day treatment. The observation cultivars were planted on 20 October. Since, for intermediate analyses such as plant weight, plant height, number of leaves etc., plants are being removed from the experimental plots at three-weekly intervals, a high plant density was used initially with all the support mesh filled completely and 80 % filled. By the time the crop comes into flower, 50 % of the mesh will still be filled which is the normal winter plant density for 'Spider'.

THE APPLICATION OF GROWTH REGULATORS TO GLASSHOUSE CROPS

THE EFFECTS OF POLLINATION AND THE MOMENT OF GROWTH REGULATOR SPRAYING ON THE FRUIT SET OF EGGPLANTS *(W. van Ravestijn and P.E. de Vreede)*

Last year, the effects were studied of growth regulator sprays applied to castrated flowers and to entire flowers on the day of anthesis or on subsequent days (see Annual Report 1982, p. 37). This year, the cvs. 'Adona' and 'Claresse' were used to study the effects of pollination and the stage of growth regulator applications before and after the start of flowering i.e. 'early' and 'late' spraying. The standard spray mixture of 20 mg/l 4-CPA + 500 mg/l iprodione was used again.
Pollination in addition to applications of growth regulators is a waste of time. In the absence of growth regulators, pollination will result in improved yields, but not to the same extent as may be achieved with growth regulators. The yield differences between 'early' and 'late' growth regulator applications are small. Early spraying generally results in more fruit than late spraying. However, the average fruit weight obtained with late spraying is greater than with early spraying.

IMPROVEMENT OF THE FRUIT YIELD IN COURGETTES WITH THE AID OF GROWTH REGULATORS *(W. van Ravestijn and P.E. de Vreede)*

The investigation carried out in 1982, (see Annual Report 1982, p. 38), in which attempts were made to increase the yields by the early induction of female flowers with the aid of ethephon and by improving the fruit set with the aid of 4-chlorophenoxyacetic acid (4-CPA = Tomatotone), was continued.
Ethrel (240 mg/l a.i.) was applied during the first true leaf stage. This produced seven female flowers extra in the leaf axils 4 to 12, compared with the unsprayed plants. Fruit set was promoted by hand pollination or by spraying the flowers with various concentrations of Tomatotone . Ethrel made the plants more sensitive to Tomatotone which resulted in hormone damage to the leaves and growing points at the higher Tomatotone concentrations.

No symptoms were observed on plants which had not been treated with Ethrel. Spraying the flowers with growth regulators took about the same time as hand pollination. Therefore spraying did not result in time savings.
Before the end of the crop, some of the plants were sprayed once with Curbiset at a rate of 24.75 mg/l a.i. The yields were temporarily increased four and seven days after the spray treatment, with the Curbiset treated plants yielding 2.2 fruits per plant and the untreated plants 0.7 fruits per plant.

BREAKING THE DORMANCY IN FREESIAS *(W. van Ravestijn and P.E. de Vreede)*

Last year, the effects of ehtylene gas, benzyladenine and cortisones on the breaking of dormancy in freesia corms were studied (see Annual Report 1982, p. 38). None of the treatments proved to be a suitable substitute for the storage treatment of freesia corms. This year, the effects of a certain amylase were studied.
Corms of cv. 'Ballerina' were stored at 30^{0} C for 0, 4, 8, 12 or 16 weeks, after which they were either left untreated, or they were immersed for 20 hours in water or in solutions of 2.5, 5, 10 or 20 mg/l amylase (type XI-A from Bacillus subtilis).
The amylase treatments did not promote early chitting of the corms.

IMPROVEMENT OF THE SUGAR CONTENT OF MELONS BY MEANS OF GROWTH REGULATORS *(W. van Ravestijn and P.E. de Vreede)*

Last year, melons were injected and/or sprayed with an ethylene inhibitor (amino-oxy-acetic acid), with 1-aminocyclopropane-1-carboxylic acid and with Ethrel (see Annual Report 1982, p. 38-39). The effects were slight.
This year, sprays of silver thiosulphate (1, 2 or 4 times 17.5 mg/l $AgNO_3$ and 17.5 mg/l $Na_2S_2O_3.5H_2O$) or Ethrel at rates of 1440, 2160 and 2880 mg/l a.i. were applied to young fruits (> 30 cm) in order to manipulate the sugar content by delaying or advancing ripening. This was achieved but the effect on the sugar content was slight.
Wrapping the young fruits in polythene bags delayed ripening and reduced the sugar content. The effects were increased by adding ethylene to the bags and they were reduced by adding $KMnO_4$ which binds ethylene.
Spraying with silver thiosulphate, followed by Ethrel sprays 0, 1, 2 or 3 weeks later was tried for observation. It seems likely that the longest period between the two spray applications (3 weeks) offers the best chance of obtaining fruits with high sugar contents.

INDUCTION OF ROOT GROWTH IN CHRYSANTHEMUMS WITH THE AID OF CORTISONES *(W. van Ravestijn and P.E. de Vreede)*

Two chrysanthemum cultivars, 'Cassa' and 'Rivalry', were used to study the effects on rooting by indolbuteric acid (IBA 0.2 and 0.4 %), by cortisones (hydro-, dihydro- and tetrahydrocortisones at rates of 20 and 40 mg/kg) and by all possible combinations of IBA and cortisones.
Only IBA 0.4 % improved rooting. The cortisones were not effective, probably as a result of uneven distribution in the talcum powder carrier base.

VEGETATIVE PROPAGATION IN VITRO OF ASPARAGUS SETACEUS *(W. van Ravestijn and P.E. de Vreede)*

In 1982, (see Annual Report 1982, p. 40), the impressions were gained that increasing fructose concentrations of the medium produced more roots, that the lowest rate of indolacetic acid (0.01 mg/l) was the most satisfactory and that a 12 hour day at 27^{o} C was to be preferred. This year, the following aspects of root induction were studied:
- the effect of the origin of the explants (from either one glasshouse or one growth chamber) which were transferred to two media (a rich and a poor one) at monthly intervals throughout one year,
- the effects of the addition of Ethrel at rates of 0 and 0.48 to 480 mg/l a.i., and of Ancymidol at rates of 0 and 25 x 10^{-9} to 25 x 10^{-1} m g/l a.i.,
- the effects of placing the explants in the dark for periods of two or four weeks and at various temperatures, i.e. 5, 10, 15 and 20^{o} C.

At present, the explants have been in the media for too short a time to be able to report any results.

THE GENERATIVE DEVELOPMENT OF STOCKS (MATTHIOLA INCANA) *(W. van Ravestijn and P.E. de Vreede)*

The first changes in the growing points of stocks during the development from the vegetative to the generative stage have been recorded on colour slides. It appears that stocks follow the same pattern in flower initiation as has been observed previously cauliflowers and broccoli.

PHYSIOLOGICAL DISORDERS

GLASSINESS IN LETTUCE *(N. van Berkel)*

It has been observed on several occasions that the occurrence of glassiness in lettuce is related to the EC (electrical conductivity) of the soil.

The lower the EC, the higher the incidence of glassiness. On lettuce nurseries the disorder may be reduced or prevented by the application of a fertiliser dressing which increases the EC of the soil.

It is assumed that glassiness is caused by root pressure which, if it becomes sufficiently high, will replace the air in the tissues with water resulting in transparent areas in the leaves (glassiness). It is believed that glassiness increases on the one hand as a result of a low EC which makes the uptake of water and ions easier, thus increasing root pressure, whilst on the other hand a low EC reduces the S/R ratio. (S/R is the quotient of the dry weights of the shoots and the roots). At lower S/R rations, there are relatively more roots which probably stimulate the uptake of water and ions, thereby increasing the root pressure. This theory is supported by the observation made in the case of chinese cabbage which showed that the S/R ratios were lower with decreasing EC levels.

The effect of the EC on the S/R relationship was investigated in two experiments with lettuce. The degree of glassiness was also determined.

In the first experiment, water with EC levels of about 1, 2, 3 and 4 mS flowed past lettuce plants growing in soilblocks. A nutrient solution designed specifically for lettuce was used. Two cultivars were planted, 'Pallas' which is susceptible to glassiness and 'Panvit', a less sensitive cultivar. The experiment started on 29 November 1982 and was terminated on 9 February 1983.

In the second experiment, the EC levels were spread further apart, i.e. 0.75, 1.5, 3.0 and 4.5 mS. Instead of plants in soilblocks, the plants were grown without soil, suspended in circulating water. The glassiness susceptible cultivar 'Renate' and again the less sensitive cultivar 'Panvit' were used in the experiment. The second experiment started on 27 September and was terminated on 19 December 1983.

In both experiments, growth at the lower EC levels was significantly retarded compared with that at the higher EC levels. The leaves developed less as a result of reduced expansion of the cells. The plants in both experiments displayed symptoms of Mn excess, i.e. necrotic spots on the edges of the older leaves. The lower the EC, the greater the number of necrotic spots.

In the second experiment, the Mn excess symptoms were greatly reduced when the nutrient solutions were replaced with new solutions containing only one-third of the Mn content and with a higher pH. Parallel with the highest Mn values, the highest values of other multivalent cations were also found at the lowest EC levels.

The S/R quotients of the plants were determined on several occasions. Collection of the roots from the soilblocks was much more laborious, as well as giving qualitatively less reliable results, than the sampling of soilless roots. The degree of glassiness was also evaluated on a number of occasions. In the first experiment, there was no significant difference between the S/R's of 'Panvit' at EC 1 and 2, but the S/R of 'Pallas' appeared to be lower at EC 2. EC 3 produced the highest S/R ratio. The S/R values increased with time.

In the second experiment, the lowest S/R ratio was clearly the one produced by the lowest EC level. In the case of 'Renate', the S/R increased up to EC 3 and decreased again at EC 4 to about the same ratio as at EC 2.
In the case of 'Panvit', there was little difference between the three highest EC levels. Eventually, the S/R's increased from about 5 to 9 and 10. Most of the glassiness in 'Pallas' and 'Renate' occurred at the lowest EC level and decreased at the higher EC levels. There was hardly ever any glassiness at EC 4. In the case of 'Panvit', there always was less glassiness and at EC 3 and 4 there was no glassiness, or rarely so.
The incidence of glassiness decreased with advancing age of the plants. Most glassiness occurred when the plants were four to six weeks old. It is likely that glassiness decreases as a result of the increasing S/R ratio. This is not the only explanation because the EC level also plays a part. Even with low S/R ratios, there was no glassiness at EC 4.
Every time plants were removed from the second experiment, they were replaced with young plants which meant that there were various planting dates. On 19 December, all the plants were harvested. The same trends were observed as in the plants planted in September i.e. the lowest S/R ratio at the lowest EC level and S/R ratios increasing with time. In this case, the S/R ratios varied from 3 to 7.
The incidence of glassiness followed the same pattern as previously. Towards the end of the second experiment, equipment became available which makes it possible to measure the root pressure after the tops have been cut off. It is hoped that this will provide the necessary insight into the relationship between EC levels and root pressure.

THE EFFECTS OF ENERGY-SAVING MEASURES ON THE QUALITY OF GLASSHOUSE AIR AND CROP YIELDS *(H.G. Wolting * and N. van Berkel)*

The purpose of this investigation is to determine the possible negative effects of harmful byproducts of CO_2 enrichment and other pollutants present in the glasshouse air on the growth, yields and quality of glasshouse crops.
First of all, an inventory will be drawn up of the concentrations of CO_2, NO_x, C_2H_4, O_3 and SO_2 in and outside glasshouses fitted with energy-saving installations. The next step is to install small growing compartments within a glasshouse, supplied with filtered and unfiltered air, in which the effects of aerial pollutants present in the glasshouse may be studied on crops growing in the compartments.
Additional research into the effects of various mixtures of CO_2, NO, NO_2, SO_2 and O_3 in different concentrations will be carried out at the Research Institute for Plant Protection at Wageningen.

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6. DEPARTMENT OF HORTICULTURE AND GLASSHOUSE CLIMATE

C.M.M. van Winden

TOMATO

THE EFFECTS OF LIGHT INTERCEPTION ON THE YIELDS OF TOMATO *(K. Buitelaar)*

A 520 m^2 site in a 1600 m^2 glasshouse was divided up into nine experimental plots. A single agryl cloth screen was suspended over the crop on three of the plots, a double agryl screen was suspended over another three plots and the last three plots were left without a screen. Compared with the unscreened plots, the light reduction under the single screen was 19 % and under the double screen 32 %.
The same space temperature was achieved in all the plots by isolating the heating pipes. Water and fertilisers were applied in the same quantities to all the plots. Tomatoes cv. 'Abunda' were planted out on 6 January. No differences were found between the three treatments with respect to the rate of flowering of six successive trusses on the plants. There was no effect of the degree of light interception on the development period of the fruits.
The fruits were picked between 28 March and 8 June. The following yields were obtained: unscreened - 165 fruits per m^2 or 11.7 kg per m^2, 71 g average fruit weight; single screen - 155 fruits per m^2 or 9.3 kg, 60 average fruit weight; double screen - 138 fruits per m^2 or 7.7 kg, 56 g average fruit weight. Compared with the unscreened control, the single screen resulted in a 21 % yield loss and the double screen in a 32 % yield loss.

A STUDY OF THE EFFECTS OF VARIOUS GABLE INSULATION MATERIALS ON THE YIELDS OF EARLY TOMATOES *(K. Buitelaar, G.W.H. Welles and G.P.A. van Holsteijn)*

Four different gable insulation materials were compared on a nursery in 1982 (see Annual Report 1982, p. 45). The investigation was repeated in a more modern glasshouse on another nursery in 1983. The following materials were compared on the north and south gables of the glasshouse: single glass, single glass + EVA film, double glass, single glass + polycarbonate and single glass + bubble film aluminised on both sides. The tomatoes were planted out on substrate on 5 January. As a result of isolation of the heating pipes, the space temperatures obtained behind the materials were practically the same. Flowering and fruit set showed hardly any response to the light reduction by the materials. Between the various materials on the north gable side, there were hardly any differences between the yields obtained until 10 August. On the south side, the yield loss behind the aluminised film extended to a distance of 12 metres away from the gable and behind the polycarbonate to 6 metres from the gable. The yields obtained behind EVA film and double glass did not differ very much from those obtained behind single glass.

Yield reductions were caused by lower numbers of fruits harvested and by lower average fruit weights. Irrespective of the insulation materials used, the yield levels behind the north and south gables in the first 3 metre strip were 3 to 4 kg per m^2 below those in the strip between 3 and 6 metres from the gables.
Since the plants were trained at an angle in the direction of the gables, the crop covered the gable surface quite early on, resulting in an additional light intercepting situation behind all the insulation materials. As in 1982, the impression was gained in this investigation that any light loss caused by the gable insulation can quickly lead to yield losses. Gable insulation is therefore best carried out with the aid of mobile gable screens which do not cause extra light interception and which can reduce horizontal temperature differences.

RESEARCH INTO THE MINERAL AND WATER RELATIONSHIPS IN EARLY TOMATOES GROWN IN VARIOUS HUMIDITY REGIMES IN SINGLE AND DOUBLE GLAZED GREENHOUSES

(G.W.H. Welles, K. Buitelaar and J.C. Bakker)

The investigation into the effects of the nutrient concentration in combination with the root temperature under different climate conditions was continued on the basis of the results obtained with early heated tomatoes in 1982 (see Annual Report 1982, p. 44).
Four climatic treatments were applied in eight double glazed glasshouse compartments and the results were compared with an untreated control under single glass. The treatments consisted of a permanent plastic film screen which was left in position for periods of 0, 4, 6 and 8 weeks after the plants of cv. 'Abunda' were set out on the rockwool slabs on 24 December. In each compartment, 12 root environment treatments were applied, i.e. 6 EC treatments combined with 2 root temperatures.
The EC levels used were 2.0, 4.0, 6.0, 10.0 and 15.0 mS/cm until the stage when the plants were allowed to root through into the slabs (around 20 January), when the EC levels in all the treatments were reduced to 2.0 mS/cm. There was also one treatment with an EC value of 2.0 mS/cm in which the plants were allowed to root through into the slabs immediately after having been set out on 24 December. The root temperatures were maintained at 18^{o} C (control) and 24^{o} C.
Up to 18 February, the plants transpired 24 % less under double glass and 42 % less under double glass plus a fixed screen, than under single glass. The sudden removal of the screens during sunny weather did not lead to the problems expected, such as leaf scorch and blindness of the heads. As in the previous years, the plants grew away faster under higher atmospheric humidity conditions and under lower light levels and they had a somewhat smaller leaf surface area, than the plants under single glass. With regard to rate of flowering and fruit set, no significant differences could be demonstrated. Three times as many bent trusses were counted under double glass (with screen) than under single glass.
On 12 April, slightly more Mg deficiency and slightly less blossom end rot were found under double glass than under single glass.

As in the previous year, the total level of these deviations was highest at the highest EC level without heating of the rockwool slabs. However, it was significantly less than in 1982 as a result of the rapid reduction in EC levels.
As in 1982, the incidence of Mg deficiency was reduced by the maintenance of a higher root temperature, especially at the highest EC starting level of 15 mS/cm. The differences in Mg deficiency did not result in yield differences: except at the highest EC level, the differences in yield levels as a result of the EC treatments were not significant, whilst a higher root temperature increased the yields by about 6 %. The keeping quality of the fruit was clearly negatively affected by the higher root temperature (about 10 % reduction in shelf life), but no differences as a result of the various EC levels could be demonstrated.
As in 1982, the results of this investigation showed that the early yields obtained under double glass (with screen) were about the same as those obtained under single glass, but as the season progressed, the yields under double glass (with screen) gradually fell behind those under single glass until there was a difference of about 11 % by 13 July. The yield reductions were the result of both a lower average fruit weight and lower fruit numbers (heavier than 10 to 20 grammes). The climatic treatments did not have a significant effect on fruit quality.

EFFECTS OF THE CO_2 CONCENTRATION ON THE DEVELOPMENT AND YIELDS OF TOMATOES *(K. Buitelaar)*

Six CO_2 concentrations were applied to tomatoes, i.e. 150, 245, 430, 790, 1500 and 2870 ppm. Plants of cv. 'Abunda' were planted out on 15 December. The night temperature was set at 16^{o} C and the day temperature at 21^{o} C with ventilation at 28^{o} C. There was no relationship between the time of flowering and the CO_2 level over the period of the first six trusses per plant. Scorching of the lower leaves occurred at 790 ppm and more at the end of January and by the end of February, the young leaves in the tops of the plants were also affected. At CO_2 levels of 150 and 245 ppm, fruit set on the first three trusses was significantly less than at the higher CO_2 levels. The fruits were harvested between 11 March and 16 May. The yields obtained from the different CO_2 levels in ascending order were: 1.96, 2.71, 3.32, 3.56, 3.58 and 2.72 kg per m^2 respectively. Especially at the highest CO_2 concentration, the yields were adversely affected by leaf scorch.

PLANTING DISTANCES FOR SINGLE AND TWIN STEM SYSTEMS IN AUTUMN CROPS OF BEEFSTEAK TOMATOES *(K. Buitelaar)*

As a result of the ever-increasing cost of tomato plants, there is interest in growing the crop with two stems per plant. Plants with two heads can be raised for this purpose (see Annual Report 1982, p. 46).

In an experiment, planting distances of 37, 45, 51, 58 and 68 cm in the row for single stem plants were compared with planting distances of 68, 77, 90, 108 and 135 cm in the row for twin stem plants. In one treatment, the lateral developing near the first truss on single stem plants was also retained to provide a second stem (planting distance 112 cm). The cv. 'Dombito' was planted on 12 July. The trusses were pruned to four fruits per truss. Harvesting took place between 5 September and 14 November. Wider planting resulted in yield reductions in both systems. There were wide variations in the numbers of fruits harvested and the average fruit weights between the replicates of each treatment. This is why no definite conclusions can be drawn with regard to the relationship between the stem system, planting distance and the yields.

UNIFORMITY IN PLANT MATERIAL RAISED FROM NATURAL AND PELLETED SEED (QUICK-PILL) *(L. Lansbergen, K. Buitelaar and G.W.H. Welles)*

A greater uniformity in plant material may contribute towards further mechanisation in plant raising and increased yields. Pelleted seed of three crops was compared with natural seed of the same quality. In tomatoes, the experiment was carried out with cvs. 'Sonatine', 'Dombito' and 'Marathon', raised by three plant raisers and planted out by four growers. Sweet pepper cv. 'Bruinsma Wonder' and cauliflower cv. 'Opaal' were propagated by one plant raiser. The germination percentage, the percentage deformed plants and the plant weights were determined during the propagation stage. After planting out, the uniformity of the flowering of the first truss of the tomato plants was determined. The effect of the position of the tomato seedlings in the seed tray on their development was examined. Another aspect studied was whether malformation of the seedlings had any effect on the plant weight at the time of planting out. The following conclusions were drawn:

- Compared with the seedlings from natural seed, the tomato seed pelleted in the Quick-Pill germinated slightly better and the seedlings were initially ahead in fresh weights. The differences in plant weight had disappeared completely after a few weeks.
- The variations in plant weight at planting out in the tomato, sweet pepper and cauliflower plants, were at least as great in the Quick-Pill plants as they were in the plants raised from natural seed. No differences in the uniformity of flowering were found in the tomato plants.
- The variation in plant weights was practically unrelated to the position of the seedlings in the seed tray. Only behind the south orientated carrying edge of the seed tray were the plants noticeably smaller.
- 'Malformed' tomato plants had practically the same growth rate as sound plants.

PRACTICAL INVESTIGATION INTO THERMAL SCREENS IN TOMATO CROPS

(G.P.A. van Holsteijn)

On three nurseries with tomatoes planted at various times, i.e. 23 December, 26 January and 9 February, thermal screens with humidity gaps were installed in glasshouse compartments of about 3500 m^2. The screens remained over the crops from the time of planting out until about six weeks later. The screens consisted of 0.05 mm anti-fogging polyethylene film. Two nurseries with mobile screens made of Tyvek and LS-11 were included in the comparison.

The tomato nursery with the late planted crop was heated with warm air, the other nurseries had pipe heating systems. Extensive measurements were carried out with regard to the climate, the crops and the yields. The main purpose of the experiment was to determine whether the screen with the humidity gaps could provide a suitable energy-saving alternative for glasshouses in which mobile thermal screens cannot be installed. The results may be summarised as follows:

- The energy savings achieved with the humidity gap screens were of the order of 4 to 4.5 m^3 gas per m^2 on all the nurseries.
- The energy savings achieved with the closed screens were considerably higher with warm air heating than with pipe heating. In the case of the mobile screens, they were 45 % and 30 % respectively during the period between planting out and 1 May.
- The use of thermal screens resulted in changes in the horizontal as well as in the vertical temperature distribution.
- The relative atmospheric humidity could be controlled reasonably well both with the mobile and the humidity gap screens.

KEEPING QUALITY OF TOMATOES *(J. Janse)*

In all the experiments, tomatoes were stored at 20° C and 80 to 90 % R.H. Individual fruits were assessed daily for colour and firmness in order to determine the ripening period and shelf life. The ripening period consists of the number of days between harvest and the fruit becoming 100 % orange. The shelf life consists of the number of days between the fruit being 100 % orange and it becoming soft.

1. Effects of energy-saving measures on the keeping quality of tomatoes.

The investigation into the effects of thermal screens and double glazing on the quality was continued in 1983 (see also Annual Report 1982, p. 46-48).

Tomatoes were collected for storage at regular intervals from four experimental stations and three commercial nurseries on which comparisons were being made between a mobile thermal screen, a static screen or a screen with humidity gaps and no thermal screens. The use of a thermal screen with humidity gaps during the first six weeks of the crop, or a mobile screen, on two commercial nurseries, did not shorten the keeping quality of tomatoes. At the experimental station at Vleuten, a mobile thermal screen used on fleshy tomatoes for ten weeks, reduced the shelf life of the fruit by two days.
At the experimental station at Venlo, where various thermal screen systems are being compared, the effects of the screens on the shelf life were not very clear. In one storage experiment carried out with tomatoes from a warm air heated crop at the experimental station at Breda, the keeping quality of the fruit was reduced somewhat by the prolonged use of a thermal screen with humidity gaps. On a warm air heated commercial nursery on the other hand, the effect of screening on the keeping quality was only slight.
As in previous years, it was found at the experimental station at Venlo that growing early and autumn crops of fleshy tomatoes under double glass did not have an adverse effect on the keeping quality. On the other hand, the keeping quality of tomatoes grown in the double-glazed energy glasshouse at the Naaldwijk research station was again reduced significantly. The shelf life of fruit grown under single and double glass was 15.2 and 13.3 days respectively.
In the Denar project, the shelf life of tomatoes grown in the acryl-clad glasshouse, the futuristic glasshouse and the Venlo glasshouse with mobile screen, amounted to 11.1, 12.0 and 10.4 days respectively. In this experiment, growing the crop in soil in the Venlo glasshouse resulted in the shortest keeping quality. In an autumn crop at the Breda experimental station, the shelf life of fruit from single and double glazed glasshouses was about the same.

Effect of light interception on keeping quality

Especially in the early heated crops in 1982, it was found that double glass or thermal screens shortened the shelf life of tomatoes in many cases by 10 to 20 %. Since light is a climatic factor which is changed by the use of energy-saving measures, the effects of the amount of light on the quality and yields were determined.
The experimental treatments applied in the early heated crop consisted of three light levels, obtained by the installation of a fixed screen of the rather open woven agryl cloth which remained in position during the whole growing period. All the experimental treatments were laid out in the same glasshouse in triplicate. a single agryl screen produced a light reduction of 19 % and a double screen 32 % compared with the untreated control.

A total of six storage experiments was carried out. The ripening periods for the fruit grown in the control, under the single and under the double agryl screens were 3.8, 3.4 and 3.4 days respectively. The shelf life at these three light levels amounted to 11.8, 12.4 and 11.5 days respectively. Ripening took place a little slower in the control fruit, whilst light interception had no significant effect on the keeping quality. No explanations for the sometimes shorter storage life as a result of energy-saving measures were provided by this experiment. The physiological aspects and yields are discussed on page 47 of this Annual Report.

Effect of CO_2 enrichment on the keeping quality

The effect of the CO_2 concentration during the cropping period on the shelf life of tomatoes was investigated in storage experiments. At the end of March the storage life obtained with all five CO_2 treatments was very short, i.e. about one day. In the next two storage trials started in mid-April and beginning May, the average shelf life of the fruit grown at CO_2 levels of 150, 245, 430, 790 and 1500 ppm was 4.9, 8.6, 9.2, 9.9 and 9.4 days respectively. The effect of the CO_2 concentration on the keeping quality was not significant.

2. Effects of the truss position and the composition of the nutrient solution on the keeping quality of tomatoes.

The seed set, fruit weight and keeping quality of tomatoes were studied. Seed set was generally better in the fruits collected from higher up on the plants. Fruits of the A grade contained more than twice as many seeds as fruits of the C grade from the same truss position. In the end fruits, the differences in seed set between the grades were significantly less. End fruits of the C grade contained more than $1\frac{1}{2}$ times as many seeds as the C grade tomatoes higher up on the same truss.
Especially in the A grade, the number of seeds and the fruit weight appear to have a positive effect on ripening. Tomatoes of the A grade could be stored four days longer on average than C grade tomatoes from the same truss position. For each harvest date, the first fruits to be picked from a truss were found to have a shorter shelf life than the end fruits picked from a lower truss.

Nutrient composition and keeping quality

In a nutrition experiment carried out in an autumn crop of fleshy tomatoes, K^+ and Ca^{2+} were added to the nutrient solutions in quantities of 3.0 and 6.5, 5.5 and 5.25, 8.0 and 4.0 mmol/l respectively. The ripening period in these treatments were 6.3, 5.2 and 4.1 days and the shelf life was 2.4, 5.1 and 8.3 days respectively. Higher potash levels improved fruit colour and shelf life.

In the autumn, storage trials were carried out with round tomatoes obtained from a nutrition experiment in which various ratios of K^+, Ca^{2+} and Mg^{2+} were used in the nutrient solutions. Ripening was improved by higher potash levels. Contrary to the previous experiment, this time there was no positive effect of potash on the keeping quality.
Storage trials were carried out on three occasions with tomatoes obtained from a nutrition experiment in which five zinc concentrations were used in the nutrient solutions. Only the treatment in which zinc had been omitted from the nutrient solution, produced fruits with a significantly shorter storage life.

THE FLAVOUR OF TOMATOES *(J. Janse)*

Investigations into internal quality have become an increasingly important part of quality research in recent years (see Annual Report 1982, p. 48-49). The work consists mainly of determining the effects of various factors on the refraction (mainly sugars), titratable acid and, in 1983, also the EC of the fruits (dilution 1:9). It is known that flavour is generally improved by a higher acid content and refraction.

1. Cultivars

Determinations were carried out in round tomato cultivars in the early heated crop (4 x), in the autumn crop (5 x) and in fleshy tomato cultivars in an autumn crop (4 x). The acid contents were tested by means of variance analyses. There were very significant ($p < 0.01$) varietal differences in acid content in the early heated crop: variation in acid percentage between the cultivars 0.44 - 0.48 % and variation in refraction 4.2 to 4.5 %.
In the autumn crop with six round tomato cultivars, the differences in the percentage acid between the cultivar were also most significant ($p < 0.01$). The variations ranged per cultivars between 0.42 and 0.51 %, with the lowest acid content in the fruits of the cultivar 'E 9502'. The variation in refraction was relatively small, i.e. 3.8 to 4.1 %.
In the fleshy tomatoes, 'Buffalo' had a significantly lower acid content than the other cultivars, i.e. acid content 'Buffalo' 0.48 %, other four cultivars 0.51 to 0.53 %. The refraction differences were also small in this case, i.e. 4.2 to 4.4 %.

2. Energy-saving measures, light interception and CO_2 concentration

Double glazing

As in 1982, the double cladding of the energy glasshouse and the Denar glasshouse did not have a significant effect on the percentage acid and the refraction.

Light interception

In the light interception experiment mentioned on page 47, the EC as well as the acid contents of the fruits appeared to increase the more light levels were reduced. At light interception of 0, 19 and 32 %, the EC levels were 0.56, 0.60 and 0.65 mS/cm. The percentages acid were 0.47, 0.48 and 0.50 respectively. Light interception had no significant effects on the refraction and the dry matter contents of the fruits in this experiment.

CO_2 concentration

Fruit analyses were carried out on three occasions on tomatoes grown in the climate glasshouse at 5 CO_2 levels (150 to 1500 ppm). In this experiment, the CO_2 levels had no effect on the EC, the percentage acid, the refraction or the percentage dry matter.

3. Growing medium

Tomatoes are being grown to an increasing extent on substrate. Several experiments were carried out in order to determine whether this had consequences for the internal fruit quality. On five occasions in the course of the season, fruits of the same cultivar were collected for sampling from about ten nurseries growing tomatoes on rockwool and ten nurseries with soil-grown crops.
On average, the EC's of the fruit grown in soil and in rockwool were 0.65 and 0.60 mS/cm and the percentages acid were 0.52 and 0.48 respectively. The differences were significant ($p = 0.02$ and 0.03). On the first two sampling dates, the vitamin C contents of the fruits were determined. On average, the soil-grown and the rockwool-grown tomatoes contained 18.1 and 19.7 mg vitamin C per 100 g fresh weight respectively.
At the end of of October, tomatoes grown on rockwool or in soil on five commercial nurseries were analysed for the major elements. The fruit flesh and the internal contents of the fruits were analysed separately. The greatest differences were found in the internal parts of the fruits, particularly with regard to Na, K, Cl and P. The contents of these elements in soil-grown fruit were 3.95, 71.9, 11.43 and 1.53 mmol per litre extract respectively. For fruit grown on rockwool, the contents were 2.08, 61.0, 8.29 and 2.28 mmol respectively. From the point of view of flavour, it may be desirable for rockwool crops to increase the EC and perhaps reduce the phosphate content of the nutrient solution.

4. Truss position

An experiment was conducted to determine the effect of the truss position on the stem and the position of the fruit within a truss on internal fruit quality.

Fruits of both A and C grades were harvested for the purpose at weekly intervals. The intermingling between the truss positions and the harvest dates posed a big problem. The EC as well as the percentage acid decreased by about 20 % as the fruits were harvested later or from the higher trusses (truss 3 to 9). The refraction remained at a more or less constant level, whilst the dry matter contents increased significantly. The first C tomatoes in a truss seem to have a lower dry matter percentage than the fruits of the same grade picked from the tip of the same truss.
With respect to EC, % acid and refraction, no significant differences could be demonstrated between A and C grade tomatoes from the same truss position.

5. Nutrient composition

In a nutrition experiment, in which beefsteak tomatoes were grown in recirculating water with various cation ratios, fruits were analysed for EC, percentage acid and refraction. The amounts of K^+ and Ca^{2+} applied in the nutrient solutions were 3.0 and 6.5, 5.5 and 5.25 and 8.0 and 4.0 mmol per litre respectively.
The EC's of the fruits with these treatments were 0.40, 0.44 and 0.55 mmol/l respectively, the percentages acid were 0.31, 0.31 and 0.41 % and the refraction percentages were 4.2, 4.3 and 4.5 %. Larger amounts of potash are beneficial for the EC and the percentage acid in the fruits and they have a slight effect on the refraction.
The internal fruit quality of round tomatoes was determined on two occasions in a nutrition experiment in which the K^+, Ca^{2+} and Mg^{2+} concentrations in the nutrient solutions were varied. Low potash and high magnesium levels were found to have a significant negative effect on the EC and the percentage acid in the fruit. In round tomatoes, grown in the energy glasshouse, EC levels of 2, 6 and 15 mS/cm were maintained in the nutrient solutions during the initial stages of the crop. At these treatments, the EC's of the fruit were 0.60, 0.60 and 0.65 mS/cm respectively and the percentages acid were 0.47, 0.47 and 0.50 % respectively.

6. Relationship between EC and percentage acid in the tomato fruit

Fruit analyses would be simplified if acid determinations could be replaced by EC measurements. In the experiments carried out in the autumn crop (220 samples), a correlation was calculated between the EC (dilution 1:9) and the percentage acid in the fruits.
The regression equation over all experiments was as follows:

$$\% \text{ acid} = 0.113 + 0.075 \times EC \quad (r = 0.83).$$

The regression coefficient depended on the origin, i.e. the type of experiment. Nutrition experiments and determinations carried out on individual fruits gave very high correlations (0.93 - 0.99), whilst the correlations in eight variety trials were significantly lower (0.36 - 0.81). In a variety trial with four replicates, the angles of the regression equations of the cultivars did not differ significantly ($p > 0.20$), but there were significant differences in intercept ($p = 0.03$).

The acid content depended on the cultivar which indicates that the acid content is determined genetically.

Relationship between the EC's of diluted and undiluted tomato pulp

In addition to the determination of the EC of diluted tomato pulp (1:9), during the second half of the season, the EC of undiluted and unfiltered tomato pulp was also measured. The relationship between the two EC measurements is shown by the following regression equation:

EC (1:9) = 0.078 + 0.129 x EC (undiluted r = 0.96).

The high correlation shows that dilution is not necessary which simplifies the EC determinations.

7. Variation in fruit composition

Individual beefsteak tomatoes obtained from a nursery with a rockwool crop and another nursery with a soil-grown crop, were analysed for the EC, percentage acid and refraction. The variation coefficients which were about the same for the two sources of the fruit, were 13, 14 and 7 % for the EC, the percentage acid and the refraction respectively. A sample of 20 to 25 fruits would seem to be necessary if no wide variations in contents are expected in experiments.

The bottom of the fruits were found to have a 0.5 to 1 % higher refraction than the top of the fruits. The percentage acid in the internal part of the fruit is about 1.5 times as high as in the fruit flesh. The refraction is practically the same, whilst the EC of the fruit flesh is perhaps slightly higher.

TOMATO CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Preliminary trials

a. Bi- to trilocular types and tri- to pentalocular types

Heated crop. Thirteen new cultivars from seven seedhouses were tested in duplicated trials on three sites against the standard cultivars 'Sonatine' and 'Abunda'. Four new cultivars were recommended for further trial.

Warm air and cold crops. Fourteen new cultivars from seven seedshouses were tested in duplicated trials on three sites against the standard cultivars 'Abunda', 'Angela' and 'Nemato'. The cultivars approved for further trial are not known as yet.

b. Multilocular (beefsteak) types

Heated crop. Seven new cultivars from four seedhouses were tested in duplicated trials on three sites against the standard cultivar 'Dombito'. Only two cultivars were recommended for further trial.
Autumn crop. Eight new cultivars from four seedhouses were tested in duplicated trials on three sites. No standard cultivar was used. The cultivars approved for further trial are not known as yet.

Decisive trials

a. Bi- to trilocular types

Heated crop. A series of eight cultivars, including the standard cultivars 'Abunda' and 'Sonatine', was tested in duplicated trials on thirteen sites. 'Abunda', 'Turbo', 'Sonatine', 'Calypso', 'Mercator', 'B81.803' and 'B 81.804' were given either qualified or unqualified approval.
Warm air and cold crops. A series of ten cultivars, including the standard cultivars 'Sonatine' and 'Abunda', was tested in duplicated trials on nine sites. 'Turbo', 'Calypso', 'B 81.810', 'Abunda' and 'Goldstar' were given qualified or unqualified approval.
Autumn crop A series of six cultivars, including the standard cultivars 'Abunda', 'Nemato' and 'Angela', was tested in duplicated trials on seven sites. The results will become known in the course of 1984.

b. Multilocular (beefsteak) types

Heated crop. Two cultivars, including the standard cultivar 'Dombito' were tested in duplicated trials on six sites. Both 'B 81.832' and 'Dombito' were given qualified or unqualified approval.
Autumn crop. A series of five cultivars, without a standard cultivar, was tested in duplicated trials on six sites.
The results will become known in the course of 1984.

CUCUMBER

TEMPORARY STATIC THERMAL SCREENS OF PLASTIC FILM FOR ENERGY SAVING
(J.A.M. van Uffelen)

The following treatments were applied in a late heated crop planted on 21 February:

a. no screen
b. screening from planting until 7 March
c. screening from planting until 21 March
d. screening from planting until 7 March, after which - until 21 March - the screens were partially opened to allow for ventilation gaps during the day.

In each compartment, the transpiration of eight plants was measured and the yields and quality were determined.

Continuous screening (treatment c) reduced the transpiration by about 50 %. By arranging ventilation gaps in the screen during the daytime (treatment d), the transpiration was increased considerably, i.e. 15 to 20 % more than in treatment c. The highest yields were obtained with a fortnight's screening (treatment b). As in 1982 (see Annual Report 1982, p. 52), higher yields were obtained in the treatment in which the screens were removed first than in the control treatment.

Screening for four weeks resulted in a yield loss compared with the control treatment, even if ventilation gaps were arranged in the screens during the daytime. The prolonged use of the screens clearly had a negative effect on the quality of the fruits. In the compartmennts where the fruits had developed under the closed screens, both the shape and the colour of the fruits were much less satisfactory.

PLANTING DENSITIES *(J.A.M. van Uffelen)*

An experiment was carried out in a late heated crop in which the yields and quality obtained at two different plant densities - 1.4 and 2.1 plants per m^2 - were determined. The highest plant density produced the largest number of fruits (10 % more than at 1.4 plants per m^2), but the average fruit weight in this treatment was 10 % lower. Although no yield differences in terms of kg per m^2 between the two plant densities could be demonstrated in this experiment, because of the poorer fruit quality at the higher plant density, the recommended plant density must be 1.4 plants per m^2.

EFFECT OF THE NUMBER OF STEM FRUITS RETAINED ON THE YIELD *(J.A.M. van Uffelen)*

An experiment was carried out in a late heated crop planted on 21 February, in which the position and the number of stem fruits retained on the plant were varied. The following treatments were applied:

1. from the seventh leaf, all stem fruits retained
2. from the seventh leaf, one fruit per axil retained
3. from the seventh leaf, one fruit retained per two axils
4. from the eleventh leaf, all fruits retained
5. from the eleventh leaf, one fruit per axil retained
6. from the eleventh leaf, one fruit retained per two axils

The number of fruits harvested was greater, the more fruits were retained on the plants in an earlier stage. However, the more fruits were retained per plant, the lighter the fruits become. This was most pronounced in the early yields, i.e. 20 % difference between treatments 1 and 6. The differences between treatments 1 and 3, and also between treatments 4 and 6, were about 10 %.

In the early stages of the crop there were few differences between the total weights harvested. The yields were slightly higher when the fruits were retained from the seventh leaf onwards than from the eleventh leaf onwards. Later on, higher (kg) yields were obtained the more the crop was thinned and this was true for fruit retention from both the seventh and eleventh leaf onwards. With retention of all the fruits from the seventh or eleventh leaf, fruit quality was usually poor. Fruit shape, weight and colour were often unsatisfactory. All this means that the number of stem fruits which are retained should not be too great. An excessively large number of fruits results in a lower kg yield as well as inferior fruit quality. The height at which the first fruit may be retained depends on the vigour of the plants and is therefore also highly dependent on the time of the year.

EFFECT OF THE CO_2 CONCENTRATION ON THE YIELD *(J.A.M. van Uffelen)*

The yields of cucumbers at six CO_2 levels were determined. The cucumbers were planted on 15 December and on 26 January, one of the six rows of plants from each compartment, used for destructive observations, was transplanted.

The CO_2 concentrations aimed at were 150, 245, 430, 790, 1500 and 2870 ppm. Ventilation was limited to a minimum in order to achieve these levels as far as possible. Ventilation was used only at space temperatures above 28° C.

The vegetative growth was best at 790 ppm. The growth was visibly less at the lowest CO_2 level and at the higher values - particularly at 2870 ppm - severe leaf scorch occurred. The latter also had a very adverse effect on the yields obtained in this treatment, especially during the first months of harvest. Later on, when the high CO_2 levels were not achieved as a result of increasing ventilation, the yields improved.

An increase in the CO_2 level from 245 to 790 ppm, increased the yields by more than 40 %, both in the crop planted on 15 December and on 26 January. At 150 ppm, the yields were significantly lower. The yields obtained at 430 ppm were intermediate between the yields obtained at 245 and 790 ppm.

The quality, especially with respect to fruit colour, was often inadequate as a result of the frequent high temperature and atmospheric humidity levels caused by limited ventilation.

Attempts were also made to apply different CO_2 levels in a summer/autumn crop. However, it was possible to achieve the required CO_2 levels to a very limited extent only. One reason was that rather high CO_2 levels accumulated during the night which took a long time to be removed by scrubbing from the compartments in which low levels were required.

Another reason was that temperatures tended to build up quickly in the morning which made early ventilation necessary. The first impression is that any differences recorded were slight and not significant. Most of the data obtained have to be processed as yet.

EFFECTS OF GABLE INSULATION ON THE YIELDS OF AUTUMN CUCUMBERS

(J.A.M. van Uffelen)

An experiment was carried out on a commercial nursery in order to determine the effects of various gable insulation materials on the yields. Following a crop of early heated tomatoes, an autumn crop of cucumbers was planted on this nursery on 22 August. The following gable insulation materials were installed on the north as well as the south side of the glasshouse:

1. reflective bubble film (plus single glass)
2. polycarbonate (double-walled) sheets (plus single glass)
3. double glass
4. plastic film (plus single glass)
5. control - single glass

In each treatment, observations were carried out on six plants in two rows (i.e. a total of 12 plants), extending to six metres from each gable. Compared with the control (single glass), the yields on the southside were 10 % higher behind the plastic film insulation, 3 % lower behind double glass, 11 % lower behind polycarbonate and 18 % lower behind reflective film. On the north side, yields were 1 % higher behind single glass plus plastic film, 4 % lower behind reflective film, 6 % lower behind polycarbonate and 11 % lower behind double glass. The differences on the south side are clearly greater, particularly with regard to reflective film. It is also interesting that the use of single glass plus plastic film results in higher yields than single glass alone. Although in this experiment no temperature measurements were carried out behind each insulation material, it may be expected that temperature differences occurred as a result of reduced radiation. However, the data confirm the impression that even in summer, light is the limiting factor for yields.

THE EFFECTS OF THE GLASSHOUSE CLIMATE, TOGETHER WITH THE ROOT ENVIRONMENT, ON THE INCIDENCE OF LEAF YELLOWING IN AUTUMN CUCUMBERS GROWN IN SINGLE AND DOUBLE GLAZED GLASSHOUSES *(G.W.H. Welles, J.A.M. van Uffelen and J.C. Bakker)*

Leaf yellowing is a disorder found in cucumbers during the months of September and October during windstill, warm and moist weather, which can result in considerable yield and quality losses. In the energy glasshouse, four climate treatments were applied under double glass and compared with a control treatment under single glass, i.e.:

a. no minimum pipe temperature and minimum ventilation
b. no minimum pipe temperature and minimum ventilation, combined with thermal screens during the night

c. minimum pipe temperature (45° C) and minimum ventilation during the night
d. minimum pipe temperature (45° C) and minimum ventilation during day and night
The planting date and the start of the treatments was 18 August. Within each climate treatment, four Ca levels were maintained in the nutrient solutions (1.50, 2.50, 3.50 and 4.50 mmol/l), compensated by K and Mg contents, and three constant EC levels, i.e. 2.0, 4.0 and 6.0 mS/cm.
Until 8 November, there was no trace of leaf yellowing, although there was a certain degree of leaf death at the bottom of the plants. The more the plants were able to transpire, the more leaf death and the less leaf distortion and Fe deficiency occurred. A higher EC of the nutrient solution reduced leaf distortion and Fe dificiency. There was a reliable negative relationship between the amount of Ca in the nutrient solution and the degree of leaf distortion. A higher Ca availability for the roots also significantly reduced susceptibility to stem Botrytis but there was no significant difference in the incidence of Botrytis between the EC treatments. With regard to the climate treatments, the incidence of stem Botrytis increased under conditions of high transpiration rates (treatment d).
As in the tomato investigations, it was also found in this experiment that yields under double glass were lower than under single glass. By the end of the experiment, about 14 % less fruit weight had been harvested under double glass than under single glass and about 34 % less under double glass with continuous minimum pipe temperature. In contrast to the tomato investigations, the yield losses in cucumbers were caused mainly by abortion of the fruit embryos and the lower numbers of fruits harvested.
Compared with a low EC (2.0 mS/cm), a high EC (6.0 mS/cm) resulted in a yield depression of more than 30 %. Under conditions of high transpiration, the difference was more than 37 % to the disadvantage of the high EC.
Apart from the interaction between the climate and the root environment mentioned, there were other interactions between the climate treatments and the root environment, as well as between the root environment factors.

THE EFFECTS OF RAPID CLIMATE CHANGES ON THE WATER RELATIONSHIPS OF THE CROP AND THE INCIDENCE OF DISORDERS *(J.C. Bakker)*

A sudden climate change was applied to a fully-grown cucumber crop by rapid opening of the ventilators. The transpiration pattern, leaf thickness, leaf temperature and climatic factors were monitored. The transpiration reached a very high level after which it dropped off sharply. The leaf thickness decreased considerably, but was restored again after about 30 minutes.
In cucumbers and tomatoes, a static thermal screen was opened completely in a single operation in order to obtain a climatic change. There were clear effects on the transpiration, leaf thickness, water status and the resistance of the stomata. In spite of the rather profound effect on the water relationship, no adverse effects of these climatic shocks were observed.

EFFECTS OF CROP ACTIVATION, PLANTING SYSTEMS AND FRUIT LOAD ON THE INCIDENCE OF BURNING OUT IN CUCUMBERS *(J.C. Bakker)*

A cucumber crop was activated during the summer months by limiting the moisture loss from the glasshouse to a minimal level, i.e. 3.5, 2.5 and 1.5 g per m^{-2} per min^{-1} during the day and to 1.5 and 1.2 g per m^{-2} per min^{-1} during the night. Two planting systems (single and twin stem systems) and two fruit loads (with or without the stem fruits) were included in the experiment.
No significant differences between the climate treatments could be demonstrated since there were very few burnt out heads in the crop. Burning out occurred only in the single stem planting system and these plants also suffered from leaf distortion. Analyses showed that the plants in the single stem system contained less calcium in the growing points.

THE INCIDENCE OF LEAF DISTORTION IN CUCUMBERS *(J.C. Bakker)*

Leaf distortion occurred in cucumbers in various experiments. The disorder is caused by calcium deficiency. In one glasshouse compartment, the disorder was found only under a static thermal screen, in another compartment there was a clear relationship with the calcium content of the nutrient solution and in a third compartment the disorder occurred only in plants in a single stem planting system (see above). There is a definite relationship with calcium and the effect of the climate is probably an indirect effect taking place via the calcium uptake. Further research will be carried out to study these aspects.

KEEPING QUALITY OF CUCUMBERS *(J. Janse)*

A great deal of quality research was again carried out in cucumbers in 1983. In all the experiments, the fruits were stored at a temperature of 20° C and a relative humidity of about 90 %. The fruits were assessed for colour at the start of the storage period and again after 7 days' and 14 days' storage. Points between 1 and 9 were awarded according to a colour scale in which 9 = dark green, 6 = just suitable for export, 4 = 50 % yellow and 1 = completely yellow.

1. Effects of energy-saving measures on the keeping quality of cucumbers

In 1982, double glazing and a static thermal screen were generally found to have a negative effect on the keeping quality of cucumbers (see Annual Report 1982, p. 55 - 56). This is why the storage experiments in which the effects of energy-saving measures on fruit colour were being studied, were continued in 1983.

Mobile thermal screen

At the experimental station at Breda, comparisons were made between an unscreened heated crop and a heated crop with a mobile thermal screen. At the Venlo experimental station, similar comparisons were made in pipe heated and warm air heated crops. Although the differences in fruit colour were generally small, the mobile screen possibly had a somewhat negative effect on the fruit colour after storage.

Double glass

Heated crops under single glass, with or without a mobile thermal screen, were compared with crops under double glass on three experimental stations. The effect of double glazing depended on the origin of the cucumbers, but on average there were no significant differences in fruit colour between the two treatments. In an autumn crop grown in the energy glasshouse at the research station, the effects of single and double glazing on the fruit colour at the beginning and end of the storage period were about the same. During the same growing period, the crop under double glass at the experimental station at Breda produced significantly lighter fruits. The same trend was observed to a much smaller extent at the experimental station at Sappemeer.
In an autumn crop grown in the Denar glasshouse, the colour scores for cucumbers from the acryl glasshouse, the futuristic glasshouse and the Venlo glasshouse with mobile thermal screen were 5.4, 5.4 and 5.2 respectively after two weeks' storage. The slightly inferior fruit colour obtained from the Venlo glasshouse was caused by the greater colour loss during storage of the soil-grown cucumbers from this glasshouse.

Effects of CO_2 concentration on the keeping quality of cucumbers

Cucumbers from the CO_2 experiment in the climate glasshouse were included in storage experiments on seven occasions. The CO_2 levels maintained in the glasshouse compartments were 150,245, 430, 790, 1500 and 2780 ppm respectively. The fruit colour at the beginning of storage for these levels was assessed as 7.1, 7.1, 7.1, 6.7, 7.2 and 7.0. After two weeks' storage, the colour scores were 4.5, 4.9, 4.4, 4.5, 4.9 and 4.9 respectively. No significant effect of the CO_2 concentration on the keeping quality could be therefore be demonstrated in this experiment. Neither could significant differences in the dry matter contents of the fruits be demonstrated.

2. Effects of the growing medium on the keeping quality of cucumbers.

An extensive investigation was carried out in 1981 into the effects of growing in soil or rockwool on the keeping quality (see Annual Report 1981, p. 51-52). In the Denar glasshouse, autumn cucumber crops were grown in soil as well as in rockwool.

The fruit colour of soil-grown and rockwool-grown cucumbers was 6.9 and 7.0 at the beginning of the storage period, and 5.1 and 5.6 after two weeks' storage. The rockwool fruits therefore had a smaller colour loss. At the Venlo experimental station, three storage experiments were carried out with cucumbers from warm air heated crops. The colour of soil-grown and rockwool-grown fruit was assessed at 7.8 and 7.6 at the beginning of the storage period and at 6.2 and 5.9 after two weeks' storage.

3. Effects of the nutrient level on the keeping quality of cucumbers.

The effects of the EC level on the keeping quality were studied in a heated crop on substrate. The following EC levels were maintained in the nutrient solutions: 1.5, 2.0, 3.5, 5.0 and 7.0 mS/cm. The dry matter contents of the fruits were 2.8, 2.9, 3.0, 3.2 and 3.4 % respectively. The points awarded for fruit colour at the beginning of the storage period were 7.0, 7.2, 7.7, 8.0 and 8.2 respectively. After a fortnight's storage, the fruit colour scores were 5.1, 5.3, 5.9, 6.1 and 6.3.
A higher nutrient level increased the dry matter content and resulted in a better fruit colour before and after storage. The colour at the beginning of the storage period determined the keeping quality.
In the autumn, three EC levels were maintained in the energy glasshouse, i.e. 2, 4 and 6 mS/cm. After three storage trials, the fruit colour at the beginning of the storage periods was assessed at 7.2, 8.1 and 8.3 respectively and after a fortnight's storage at 5.0, 5.6 and 6.0. These results show the same pattern as in the previous experiment.

4. Nutrient composition and keeping quality of cucumbers

The effects of several organic acids in the nutrient solutions on fruit quality were studied in two storage experiments with cucumbers grown on rockwool. Generally speaking, the effect on fruit colour was not clear. No significant differences in colour were found in the two storage experiments between cucumbers grown in nutrient solutions containing three different concentrations of silicates in combination with two concentrations of phosphate.
In an autumn crop in the energy glasshouse, four calcium levels were maintained in the nutrient solutions, i.e. 1.5, 2.5, 3.5 and 4.5 mmol per litre. Increased calcium levels were combined with less potash and magnesium in the nutrient solutions. At the beginning of the storage period, the colour scores at these Ca levels were 6.9, 6.8, 6.9 and 7.2 respectively, with scores of 5.5, 5.2, 5.0 and 5.0 after a fortnight's storage. As a result of the development of so-called 'old age spots' on the fruits grown at higher Ca levels, the colour loss increased with more calcium and less potash and magnesium present in the nutrient solutions.

5. Effects of a low temperature regime on the keeping quality of some cucumber cultivars

The keeping quality of cucumbers grown under a low temperature regime (about 15° C by night and 18° C by day) was compared in two storage experiments with the keeping quality of cucumbers grown at normal temperatures.
A low temperature regime shortened the storage life of the fruit to some extent, but the colour differences between the four cultivars used in the experiment were much greater.

6. Effects of planting distance on the keeping quality of cucumbers

The effects of planting distance on the keeping quality have been studied before (see Annual Report 1979, p. 49-50).
In an experiment carried out at the research station in 1983, two plant densities were compared, i.e. 1.43 and 2.14 plants per m^2. At the beginning of the storage period, the points awarded for fruit colour at the two plant densities were 7.3 and 7.0. After a fortnight's storage, the scores were 5.2 and 4.7. The closer planting distance proved to have an adverse effect on the quality in this experiment.

7. Keeping quality of mini-cucumbers

The keeping quality of mini-cucumbers was studied in five storage experiments. Cucumbers of cv 'Corona', grown in the same glasshouse compartment, were used for comparison. The fruit colour of cv 'Corona' and the mini-cucumber cv 'Picobello' was assessed at 6.9 and 6.4 at the beginning of the storage period and at 4.6 and 3.8 after a fortnight's storage. The mini-cucumbers had a weaker colour.

8. Growing medium and flavour of cucumbers

On two occasions in spring and autumn, samples of cucumbers were collected from five nurseries with soil-grown crops and five nurseries with rockwool crops. The flavour of the fruit was assessed by a tasting panel at the Sprenger Institute. The fruits, with and without skin, were assessed for crispness, juiciness, toughness and flavour. Differences between soil and rockwool-grown cucumbers were generally small, or absent. However, the rockwool fruits - and particularly those sampled with the skin - were generally considered crisper than the soil-grown fruit, which is a positive point.

CUCUMBER CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Preliminary trials

Heated crops (normal temperature)

Six new cultivars from four seedhouses were tested in duplicated trials on four sites against the standard cultivar 'Corona' (grown in soil as well as on rockwool). One of the new cultivars was resistant to mildew. Four new cultivars were recommended for further trial.

Heated crops (low temperature regime)

At the instigation of several breeding companies, a trial was laid on for testing cucumber cultivars under low temperatures. The temperature settings from the date of planting were 15^{o} C by night and 18^{o} C by day. On one site, the trial was grown with a thermal screen and soil heating, on another site it was grown with soil heating, but without a thermal screen.
On both sites, seven cultivars were tested in duplicated trials against the standard cultivar 'Corona'. The cultivars were supplied by five seedhouses. The yield rates and quality of the new cultivars were unsatisfactory under the low temperature regime. The new cultivars gave better yields at low temperatures than the standard cultivar, but the yields under normal temperatures were so much worse than those of the standard cultivar, that the trial had to be terminated prematurely. Also, the quality of the so-called cold-tolerant cultivars grown at normal temperatures was inferior to that of the standard cultivar and the yields were no better. It was concluded finally that there was no sense in continuing trials with the best cultivars of the cold-tolerant series.

Warm air and cold crops

Twenty-one new cucumber cultivars from nine seedhouses were tested in duplicated trials on three sites against the standard cultivars 'Corona' and 'Sandra'. All the trials were grown in soil. Nine new cultivars were resistant to mildew. Some trials were affected slightly by burning out of the heads. Eleven cultivars were recommended for further trial.

Autumn crops

Eight new cultivars from five seedhouses were tested in duplicated trials on three sites against the standard cultivar 'Corona'. Two cultivars were recommended for further trial.

Heated crops

A series of eight cultivars, including the standards 'Lucinde' and 'Corona', was tested in duplicated trials on thirteen sites. The plants were grown both on rockwool and in the border soil. The cultivars '703', 'Grandiosa', 'Tinda', 'Brucona', 'Corona' and 'Lucinde' were given qualified or unqualified approval.

Autumn crops

A series of six cultivars, including the standard cultivars 'Lucinde' and 'Corona', was tested in duplicated trials on seven sites. The results will become known in the course of 1984.

LETTUCE

COMPARISON OF THE EFFECTS OF A STATIC THERMAL SCREEN AND A SCREEN WITH HUMIDITY GAPS ON THE YIELD AND QUALITY OF BUTTERHEAD LETTUCE

(R.H.M. Maaswinkel)

In the season of 1982/83, investigations were carried out in three glasshouse compartments into the effects of static thermal screens on the rate of growth and quality of lettuce. Besides an unscreened compartment, one compartment was equipped with a static screen of plastic film and the third compartment was equipped with a static plastic film screen in which humidity gaps had been left. The compartments were planted up in seven stages with the cultivars 'Columbus', 'Pascal' and 'Pallas'. The planting dates were 3, 13 and 23 September, 15 October, 12 November, 14 December and 19 January.
In addition to crop observations such as yields and quality, various climatic characteristics were recorded, including space temperatures, soil temperatures and light levels.
The results showed that both screen types had a light interception rate of about 12 % compared with outside light levels. Soil and space temperatures were highest in the compartment with the closed static screen and lowest in the compartment without a screen.
The gross headweights and the percentage waste were highest in the closed static screen compartment and lowest in the unscreened control compartment. The quality at harvest in both screened compartments was poor up to and including the planting date of 12 November. The quality of the crops of the two last plantings was reasonable to good.
The keeping quality of the lettuce from the compartment with the closed static screen was poor, that from the compartment with the humidity gap screen was a little better and the keeping quality of the lettuce from the unscreened compartment was good.

EFFECTS OF THE K/Ca/Mg RATIOS IN THE NUTRIENT SOLUTION ON THE INCIDENCE OF TIPBURN IN BUTTERHEAD LETTUCE GROWN IN NUTRIENT FILM *(R.H.M. Maaswinkel)*

In the autumn of 1983, an investigation was carried out into the effects of the cation relationships in the nutrient solution on the incidence of tipburn in butterhead lettuce grown in nutrient film. Six treatments were applied in four replicates. The cultivars 'Salina' and 'Sitonia' were planted out on 17 August. The data from this experiment have to be processed as yet.

ICEBERG LETTUCE

ARTIFICIAL LIGHTING DURING PLANT RAISING, SOIL AND SPACE TEMPERATURES FOR THE ICEBERG LETTUCE CROP *(R.H.M. Maaswinkel)*

In an experiment carried out in spring, the effects of lighting during plant raising and the effects of soil and space temperatures, with or without the use of a static thermal screen, on the head formation and yields of iceberg lettuce, were studied.

Lighting

The following treatments were applied to cv 'Cristallo' planted on 10 January: no lighting, 2400 lux per 24 hours for two weeks after sowing (11 November) and 2400 lux per 24 hours for four weeks after sowing. There was no significant difference in the development of the heads as a result of lighting. The plants which had been lit, both for two and four weeks, produced significantly heavier heads at harvest than the unlit plants.

Soil and space temperatures

In five glasshouse compartments, the following climatic treatments were applied, starting from the planting date on 10 January:
1. night temperature 7^{o} C, continuous plus static plastic film screen
2. night temperature 10^{o} C, after start of head formation 7^{o} C plus static film screen
3. night temperature 7^{o} C continuous
4. night temperature 10^{o} C, after start of head formation 7^{o} C
5. night temperature 10^{o} C, after 3 weeks 7^{o} C

The day temperature in all the treatments was 13^{o} C with 3^{o} C light rise. Two soil temperatures were maintained within each compartment, i.e. about 9^{o} C (control) and 14^{o} C.
The different night and soil temperatures did not result in significant differences in head formation. The higher night temperature had a positive effect on the gross and net head weights. Screening resulted in significantly lower head weights.

The use of soil heating up to 14° C resulted in significantly heavier heads compared with no soil heating.

LETTUCE CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Fig. 6. Testing lettuce cultivars

Preliminary trials with butterhead lettuce

New cultivars of the traditional type were tested in three cropping seasons representative of commercial practice. The trials were carried out in duplicate or triplicate on at least three sites. Seedhouses were allowed to submit a maximum of two cultivars for each crop. Most of the cultivars submitted during the season 1982/83 had resistance to all eight Dutch strains of Bremia lactucae. The trial results are shown in Table 8.

Table 8. Results of preliminary trials with butterhead lettuce (season 1982/83)

Cropping season	Type	Standard cultivars	Number of new cvs	Number of seedhouses	Number of new cvs for further trial
Autumn crop 1982	traditional	'Panvit' 'Columbus' 'Pascal'	14	7	7
Winter crop 1982/83	traditional	'Panvit' 'Columbus' 'Saffier'	13	7	6
Spring crop 1983	traditional	'Mir' 'Diamant' 'Marcia' 'Pallas'	14	7	10

Breeders appeared to have little interest in submitting cultivars of the upright type. As a result of the availability of the compounds iprodione (Rovral) and vinclozolin (Ronilan) against Rhizoctonia and Botrytis, there is also a diminishing interest in upright lettuce types from the side of growers. Only one or two cultivars of the upright type were therefore tested in 1982/83 seasons.

Decisive trials with butterhead lettuce

Only one cultivar of the upright type was tested in the decisive trials. The results of the trials of cultivars of the upright and traditional type are shown in Table 9.

Table 9. Results of the decisive trials with butterhead lettuce (season 1982/83).

Cropping season	Number of trial sites	Standard cvs	Number of new cvs	Number of seedhouses*	Recommended cvs
Early autumn crop 1982	5	'Topaas' 'Salina'	5	2	'Talent', 'Sitonia' 'Claret', 'Salina' 'Topaas'
Autumn crop 1982	18	'Panvit' 'Pascal' 'Columbus'	6	3	'Panvit', 'Columbus' 'Talent', 'Claret' 'Panlight', 'Nanda' 'Pascal'
Winter crop 1982/83	22	'Panvit' 'Columbus' 'Saffier'	5	4	'Talent', 'Saffier' 'Columbus','Amaril' 'Pandora', 'Nanda' 'Panvit', 'Panlight'
Spring crop 1983	10	'Mir' 'Diamant' 'Marcia' 'Pallas'	6	4	'Mir', 'Diamant', 'Marcia', 'Pallas' 'Baccarat', 'Riant' 'Nanda', 'Norden'

* including those supplying the standard cultivars

Heavy lettuce

In the framework of the heavy lettuce project of the three Westland auctions, a series of four lettuce cultivars was tested in duplicated trials on four sites. The cultivars recommended were 'Columbus', 'Panvit', 'Nanda' and 'Claret'

Preliminary cultivar trials with iceberg lettuce

In two cropping seasons, representative of commercial practice, new cultivars were tested on at least three sites per cropping season. Seedhouses were allowed to submit two new cultivars for each cropping season.
In the autumn crop of 1982, sown between 20 August and 5 September, six new cultivars were tested against the standard cultivar 'Cavalona'. Only the cultivar 'Kellys' was recommended for further trial.
In the spring crop of 1983, sown between mid-November 1982 and the end of February 1983, five new cultivars were tested against the standard cultivar 'Cristallo'. The cultivars '2880' and '84905' were recommended for further trial.

Decisive trials with iceberg lettuce

In two cropping seasons, representative of commercial practice, new cultivars were tested in decisive trials.
In the autumn of 1982, four cultivars were tested on ten sites in duplicated trials against the standard cultivar 'Cavalona'. The cultivars 'Sonia' and 'Cavalona' were recommended.
In the spring of 1983, five cultivars were tested on nine sites in duplicated trials against the standard cultivar 'Cristallo'. The cultivars 'Kellys', 'Marbello', 'Cristallo' and 'Formidana' were recommended.

SWEET PEPPER

EFFECTS OF NIGHT TEMPERATURE, COMBINED WITH VARIATIONS IN THE CONCENTRATION OF THE NUTRIENT SOLUTION AND VARIATIONS IN FRUIT LOAD, ON YIELDS AND THE INCIDENCE OF QUALITY DEFECTS *(J.A.M. van Uffelen)*

The results of the investigation carried out in 1982 (see Annual Report 1982, p. 63), were the reason for continuing the work. An experiment was designed in which three night temperatures were maintained in three glasshouse compartments. Within each compartment, four nutrient concentration levels and two fruit load levels were maintained. As in 1982, the yields were recorded as well as the incidence of cracked fruits.

a. Night temperatures

Plants of cv 'Propenza', sown on 6 October and raised over an extended period, were set out on rockwool on 25 January. Three temperature regimes were applied, i.e. 15, 12.5 and 10^{o} C during the night with a day temperature of 25^{o} C until 15 March and 22^{o} C from then on.
The actual night temperatures achieved were not quite the same as the values set. Initially, the lower night temperatures (10 and 12.5^{o} C) became practically the same as the highest temperature (15^{o} C) as a result of the mild weather and the fact that no surplus heat was ventilated from the glasshouse compartments.
Besides the quantitative data collected at the time of harvest, observations were also made on the incidence of cracked fruits. The fruits were assessed and awarded points from 0 to 9, in which 0 denoted complete freedom from cracks and 9 denoted very many cracks. The results are shown in the table below.

Tabel 10. The incidence of cracked fruits and yields at 3 night temperatures

Night temp.	Cracked fruits harvested*		Yields in kg per m^2 until:			
	4 + 5 + 6	7 + 8 + 9	21 - 4	6 - 5	9 - 6	29 - 9
15	3.0	1.6	1.04	2.05	3.68	13.1
12.5	3.1	1.2	0.33	2.15	3.93	12.6
10	4.5	1.3	0.65	2.54	3.91	12.7

* Average of 3 weeks' harvest.

The table shows that differences occurred only in the early yields, the later yields were practically the same. The daly in cropping as a result of the lower night temperatures remained limited to about 0.5 kg per m^2.
No, or hardly any, cracked fruits were found during the first three weeks of harvest. The same was true for the fruit picked after harvest week 9(beginning June).
During harvest weeks 4, 5 and 6, many cracked fruits were found, particularly in the 10^{o} C treatment. The disorder was much less severe during harvest weeks 7, 8 and 9, but most of the cracked fruits during that period were found in the 15^{o} C treatment. The temperature effect is therefore not quite clear, but it seems advisable not to allow the night temperatures to drop too much. The effects of the night temperature on the incidence of cracked fruits will be studied further.

b. Concentration of the nutrient solution.

In 1982, an experiment was carried out with different concentrations of the nutrient solutions (see Annual Report 1982, p. 63), in which some effects were found on the incidence of cracked fruits. The investigation was continued in 1983 with certain adjustments to the treatments. The treatments applied were:
1. concentration of the nutrient solution constantly at 5 $mS.cm^{-1}$
2. concentration of the nutrient solution initially 5 and later 2 $mS.cm^{-1}$
3. concentration of the nutrient solution initally 2 and later 5 $mS.cm^{-1}$
4. concentration of the nutrient solution constantly at 2 $mS.cm^{-1}$

The changes in treatments 2 and 3 were carried out in the first week in April (i.e. the week of first fruit pick). The four concentration treatments were duplicated in each of the three night temperature treatments mentioned under a.
The results are shown in the table below.

Table 11. Assessments of cracked fruits and yields at four EC levels

Concentration in $mS.cm^{-1}$	Cracked fruits in harvest weeks		Yields in kg per m^2 until			
	4 + 5 + 6	7 + 8 + 9	21 - 4	6 - 5	9 - 6	29 - 9
Constant 5	2.3	1.1	0.36	1.86	3.72	11.7
5, later 2	3.3	1.5	0.48	2.04	3.98	13.0
2, later 5	4.1	1.3	0.90	2.70	3.74	12.2
Constant 2	4.4	1.5	0.84	2.84	4.18	13.6

There is a big difference with regard to cracked fruits between treatments 1 and 4: a low EC level increased the number of cracked fruits. It is possible that the high root pressure which may be expected at low EC levels is the cause of the increased severity of this disorder. The level was significantly lower during harvest weeks 7, 8 and 9 and the differences were smaller, but still in favour of the high concentrations.
A high concentration reduced the yields which is contrary to the results obtained in 1982. However, the highest concentration applied in 1982 was 4 $mS.cm^{-1}$, maintained over a shorter period.

c. Fruit load

During the initial growing stages of the sweet pepper crop, no fruits are retained and any fruits set are generally removed. In order to obtain high yields, it is necessary to grow first a large plant with an adequate root system. However, the result is often that once the plants are allowed to fruit, the fruit load increases very rapidly which tends to slow down the growth of the plants and the fruits. After the first picks, the remaining fruits start to expand rapidly again, causing cracks to appear in the somewhat aged fruit skins.
This theory was tested in an experiment in which part of the fruits set was removed. In 1982, this was done by removing half of the first fruit sets. In 1983, four fruits were retained per plant and the remainder was removed ten days after first fruit set. The results are shown in the following table:

Table 12. Yields and assessments of cracked fruits in two treatments:

Treatment	Cracked fruits harvested		Yields in kg per m^2 until				Fruit weight in g until	
	4 + 5 + 6	7 + 8 + 9	21-4	6 - 5	9 - 6	29-9	6 - 5	29 - 9
Control	4.2	1.6	0.50	2.44	3.88	12.5	169	172
4 fruits per plant	4.7	1.9	0.52	2.00	4.31	13.6	198	178

We must conclude that thinning did not reduce the incidence of cracked fruits and the assessments are even lower. The rapid expansion of the fruit load did not have a positive effect on the disorder. However, there was a strong effect on the yields. By the second sampling date, the yields in the unthinned control treatment were slightly higher, but during the rest of the season, the yields from the thinned plots increased steadily. Thinning also produces a slightly better quality at harvest since the less perfect fruits can be removed during thinning. Misshapen fruits were not, or hardly, found in the first fruit set in this treatment. Thinning has therefore proved to have positive effects in this experiment.

EFFECTS OF EXTENDED PLANT RAISING PERIODS ON THE YIELDS OF EARLY SWEET PEPPER *(J.A.M. van Uffelen)*

Extending the propagation period for sweet peppers would appear to be a method of saving energy. Sweet pepper plants tend to grow rather slowly, compared with for instance cucumbers, which makes it possible to keep the plants together in a small area for a longer period.

One of the questions in extended plant raising is how long, or rather until what stage of development, the plants can be kept together at high densities. This is why an experiment was carried out with plants from different sowing dates which were given extended propagation periods. The sowing dates were 30 September, 3 October, 6 October and 9 October. All the plants were planted on rockwool in special trays on 15 December. The trays are about 50 cm long, 23 cm wide and 4.5 cm high. Each tray contains a slab of rockwool of 50 x 20 x 7.5 cm on which two plants are set out. The plant density during the extended plant raising periods was 9 plants per m^2 which was found to be too high to take proper care of the plants. However, six plants per m^2 seems to be a good compromise. The plants were placed in their final cropping position on 25 January. Because of the high density during the plant raising stage, the plants could not be given the best care which had an adverse effect, particularly on the largest plants. The results are shown in the following table.

Table 13. Yields recorded on four sampling dates from four sowing dates.

Sowing date	Yields in kg per m^2 until:			
	21 - 4	6 - 5	9 - 6	14 - 7
30 September	0.57	2.27	4.16	7.44
3 October	0.81	2.40	3.32	6.71
6 October	0.63	2.11	3.57	6.82
9 October	0.73	2.35	3.38	6.91

The inadequate care given to the plants during the propagation stage was probably partly responsible for the confusing yield figures. In past experiments, the larger plants nearly always produced the larger early yields. In this experiment, the early yields of the largest plants were also the lowest yields. Later on, the yields of these plants were clearly the highest. It is possible that the smaller early fruit set had a less weakening effect on the plants, just as in the fruit thinning experiment, which encouraged larger yields later in the season.
Investigations into the possibilities of extended plant raising periods will be continued.

QUALITY OF SWEET PEPPER *(J. Janse)*

Effects of the growing medium on the internal quality of sweet pepper

The investigation into the vitamin C and dry matter contents of sweet peppers grown on substrate was continued in 1983 (see Annual Report 1982, p. 66). Samples of red sweet peppers of the same cultivar were collected on two occasions in spring from 15 nurseries growing on substrate and 10 nurseries with soilgrown crops.
The average vitamin C contents of soil-grown and substrate fruits were 160 and 194 mg per 100 g fresh weight respectively. The dry matter percentages were 9.0 and 9.4 % respectively. The data show that, compared with soil-grown fruits, the peppers grown on rockwool had a 20 % higher vitamin C content.

SWEET PEPPER CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Preliminary trials

Heated crop

A series of seven new cultivars, six of the green/red and one of the green/yellow type, from seven breeders was tested in duplicated trials on three sites against the standard cultivars 'Bruinsma Wonder', 'Propa' (selection 'Propenza') and 'Goldstar'. Two new cultivars of the green/red type could be recommended for further trial in 1984.

Autumn crop

A series of nine new cultivars from six breeders was tested in duplicated trials on three sites against the standard cultivars 'Goldstar' and 'Propa' (selection 'Rumba'). The cultivars recommended for further trial in 1984 are not known as yet.

Decisive trials

Heated crop

A series of nine cultivars, including the standard cultivars 'Verbeterde Glas' ('Bruinsma Wonder'), 'Propa' ('Propenza') and 'Goldstar', was tested on twelve sites, in soil as well as on rockwool. Some of the new cultivars, mainly F_1 hybrids could be recommended with or without qualifications, i.e. the cultivars 'Delphin', 'Plutona', '756' and 'Calypso'.

Autumn crop

Five new cultivars of the green/red type were compared with the standard cultivar 'Propa' ('Rumba'). The results will be published in the spring of 1984.

EGGPLANT

PLANTING DISTANCES, PRUNING TREATMENTS AND GRAFTING IN THE AUTUMN CROP

(R.H.M. Maaswinkel)

The experimental design has already been described in the Annual Report 1982, p. 68. By 31 August, as well as by 9 November, the yields were highest with the narrow planting. Taking into account also the experimental results obtained in 1981, it would seem that for practical purposes the optimum planting distance is about 60 cm in a four row twin stem system. There were no significant differences in kg yields and average fruit weights between the various grafting and the non-grafted treatments. In the pruning experiment it was found that the early yields until 31 August were significantly higher with stopping of the lateral than with removal of the laterals. However, the total yields until 9 November and the average fruit weights did not show any significant differences between the two treatments.
It must be obvious, also in view of the experimental results obtained in 1981, that the least labour intensive pruning system should be selected for practical purposes.

INTERPLANTING AND GROWTH REGULATOR TREATMENTS IN AUTUMN CROPS OF EGGPLANTS

(R.H.M. Maaswinkel)

The possibilities of interplanting in a soil-grown crop of eggplant (cvs 'Adona' and 'Dobrix') following a tomato crop were studied in the autumn of 1983. Because the plants might become stretched as a result of interplanting, an observation experiment with CCC treatments was included.

The following treatments were applied: interplanting on 15 June with the tomato plants being removed on 15 July, replanting on 15 June after clearing the tomato crop, interplanting on 1 July with the tomato crop being removed on 15 July, and replanting on 1 July after clearing the tomato crop. The CCC treatments consisted of: an untreated contro, 0.4 ml/l CCC + 1 ml/l Agral, 0.8 ml/l CCC + 1 ml/l Agral, 1.2 ml/l CCC + 1 ml/l Agral and 1 ml/l Agral. The results have to be processed further yet.

ARTIFICIAL LIGHTING DURING PLANT RAISING OF EGGPLANTS *(R.H.M. Maaswinkel)*

An investigation was carried out in spring into the effects of lighting during the propagation stage on the subsequent yields of eggplants. The crop was grown in soil. The following treatments were applied: plant ages - 12 weeks (control), 10 weeks and 8 weeks. Plants of each age were given artificial lighting for 0, 16 and 24 hours. The sowing dates were 22 October, 5 and 19 November. Planting out took place on 14 January 1983 and the cultivar used was 'Adona'. The light intensity was 2400 lux applied by fluorescent lighting tubes. Supplementary lighting resulted in a more rapid vegetative and generative development of the plants and therefore heavier plants. Continuous lighting (24 hours) for four weeks resulted in yellowing of the young leaves and should therefore not be used.
Assuming similar plant weights at the outset, 20 hours' lighting per day will result in slightly higher yields than those obtained from unlit, 12 week-old plants. There were no significant differences between the treatments in the numbers of flowers aborted. An average of 70 % of the flowers were aborted during the first month of cropping.
The highest yields were obtained with temporary continuous lighting for 24 hours followed by 20 hours' lighting. Further research will have to be carried out to establish the possibilities for yield improvements in this area.

EGGPLANT CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Decisive trials

A series of three cultivars - 'Adona', 'Berinda' and 'Dobrix' - was tested in heated crops on three sites in a total of 30 replicates. The plants were grown on rockwool as well as in the glasshouse soil. All the cultivars could be recommended.

MELON

EFFECTS OF REDUCED NIGHT TEMPERATURES ON THE YIELDS AND QUALITY OF MELONS *(K. Buitelaar)*

The sugar content determines to a large extent the eating quality of melons.

For some crops it is known that a low temperature has a favourable effect on the sugar content of the produce. This aspect was investigated in melons. Cv 'Haon', planted on 1, 9 and 17 April, was grown at a night temperature of 20° C with a variation of 15 to 16° C from 16 May onwards. At the normal night temperature, fruit developments from the time of fruit set took 39 days, averaged over the three planting dates, and the refraction value was 8 %. At the reduced night temperature, the respective figures were 43 days and 9.9 %.
The yield until 8 August at the normal night temperature, averaged over the three planting dates, was 7.5 kg per m^2, with an average fruit weight of 842 g. The respective figures for the reduced night temperature were 6.9 kg and 934 g.
The reduced night temperature did not have an adverse effect on the crop habit or the incidence of diseases.

MELON CULTIVAR TRIALS *(K. Buitelaar)*

Comparison of some melon cultivars and rootstocks

Yield and quality are important considerations in the choice of melon cultivars. In order to prevent Fusarium, melons are often grafted on the rootstocks 'Benincasa'. Using cv 'Haon' as the scion, the rootstock 'Benincasa' was compared with 'no. 841' (Royal Sluis) and 'KJ 100' (Pannevis). The cultivar 'Makdimon' (Israel) was included besides the standard cultivar 'Haon'. The crop was planted on 18 April. The plants on rootstock 'KJ 100' had very poor growth. Over the harvest period from 13 June to 8 August, cv 'Haon' yielded 8.5 fruits per m^2, with an average fruit weight of 852 g and a refraction value of 8.6 %. The respective figures for cv 'Makdimon' were 6.5, 1588 and 8.1 %. The fruits of cv 'Makdimon' are too big. The crops on rootstock 'Benincasa' yielded 7.0 fruits per m^2 with an average fruit weight of 1022 g. The respective figures for rootstock 'no. 841' were 8.8 fruits per m^2 and 786 g. This rootstock is worth further trialling. 'KJ 100' proved to be unsatisfactory in this experiment.

RADISH

EFFECTS OF THE CO_2 CONCENTRATION ON THE GROWTH AND DEVELOPMENT OF RADISH *(Cl. Mol)*

An investigation was carried out into the response of radish to different CO_2 concentrations. The CO_2 concentrations applied were: 150, 245, 430, 790, 1500 and 2870 ppm. The cultivar 'Radar' was sown on 31 December 1982, using seed fraction 2.75 - 3.00 mm. Both the fresh weight and root diameter increased with increasing CO_2 concentrations up to 790 ppm. At higher CO_2 levels, the fresh weight decreased again.

POSSIBILITIES OF GROWING RADISH ON SUBSTRATE *(Cl. Mol)*

In a number of experiments, attempts were made to grow radish on rockwool, but the results so far were unsatisfactory. The best results were obtained by covering the seed with perlite, granulated rockwool or coarse sand.
Uneven root development caused excessive heterogenity at harvest and there was a lot of 'blacking' on the roots as a result of the damp environment. The investigation will be continued.

EFFECTS OF THE QUALITY OF THE WASHING WATER ON THE KEEPING QUALITY OF RADISH *(J. Janse and Cl. Mol)*

Radish is a perishable product, especially as a result of rapid yellowing of the leaves. Water of different qualities is being used on nurseries for washing the roots after harvest. The water used for the purpose ranges from relatively dirty surface water to clean mains water.
The effects of washing water quality on the storage life of radish were examined in two experiments. In both experiments, use was made of canal water, canal water to which 50 ppm chloride had been added and mains water.
After several days' storage, the radish was assessed for leaf colour, rot, pithiness and glassiness of the roots.
In both experiments, the quality of the washing water did not have a significant effect on internal or external quality of the radish. The longer the radish was stored, the more pithiness and glassiness increased. In the first experiment, 23 % of the roots displayed glassiness symptoms after four days' storage, in the second experiment the percentage was 45 % after three days.

CHINESE CABBAGE

PREVENTION OF TIPBURN IN CHINESE CABBAGE BY CALCIUM SPRAYS AND BY INSULATING THE GLASSHOUSE WITH A STATIC THERMAL SCREEN OF PLASTIC FILM *(K. Buitelaar)*

Last year, tipburn occurred in an experiment in spite of spraying with 0.9 % Ca (NO_3) (Annual Report 1982, p. 73).
In a new experiment, sprays of 0.09, 1.4 and 1.9 % Ca $(NO_3)_2$ were applied three times a week over a period of a fortnight. The cultivar 'W.R. Green 60' was planted on 18 January in two glasshouse compartments, in one of which a static plastic film screen was installed in the roof of the glasshouse. The sprays were applied between 7 and 23 February.

Tipburn appeared from 14 February onwards. By 25 February, the percentages of plants affected by tipburn in the 0.09, 1.4 and 1.9 % $Ca(NO_3)_2$ treatments were 100, 49, 9 and 0 respectively, and 100 % in the treatments with or without the thermal screen. The 1.9 % $Ca(NO_3)_2$ sprays prevented tipburn completely. Investigations into the effects of Ca sprays will be continued.

UTILITY VALUE AND KEEPING QUALITY OF A NUMBER OF CHINESE CABBAGE CULTIVARS
(K. Buitelaar and J. Janse)

Chinese cabbage cultivars display great variations in keeping quality (Annual Report 1982, p. 74). Ten cultivars were received from the Institute for Horticultural Plant Breeding which, grown as a field crop in the open, had proved to have good keeping quality. These cultivars were planted on 18 January, together with the standard cultivar 'W.R. Green 60'. In mid-February, the crop was affected severely by tipburn. 'Snow Mountain' had a fair amount of tipburn and all the other cultivars were affected very severely. After harvest on 28 March, the heads were stored at 15° C and about 90 % r.h. By the end of nine days' storage, four cultivars were in a better condition than 'W.R. Green 60'. However, none of the cultivars met the requirements of a compact, firm cabbage shape.

KOHLRABI

CULTIVAR TRIALS *(J.H. Stolk, M.R. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Preliminary trials

Heated and warm air heated crops

In both growing systems, a series of five new kohlrabi F_1 hybrids, submitted by three seedhouses, was tested in duplicated trials on three sites against the standard cultivars 'Prado' and 'Express Forcer'. The following cultivars were recommended for further trials:
Heated crop : cvs 'Foran', 'Proloog' and 'no. 486'
Warm air heated crop: cvs 'Foran' and 'Proloog'

Autumn crop

In the autumn crop, a series of nine new kohlrabi cultivars (F_1 hybrids) was tested in duplicated trials on three sites against the standard cultivars 'Quickstar' and 'Express Forcer'. The cultivar were submitted by five seedhouses. The results of the trials will be discussed in the course of 1984, in order to compile a series for further trials.

BROCCOLI

CULTIVAR TRIALS IN A SPRING CROP *(Cl. Mol)*

Twenty cultivars, obtained via the Institute for Horticultural Plant Breeding at Wageningen, were planted on 31 January. The harvest covered the period from 26 April until 16 May. On the basis of utility value and yields, the following cultivars may be recommended: 'Clipper' , 'SG 1', 'Oktal F_1', 'Southern Comet', 'Waltham', 'Gem', 'Cleopatra' and 'Green Sprouting Calabrese'. However, none of the cultivars mentioned produced yields in excess of 2.5 kg per m^2.

CAULIFLOWER

CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Decisive trials

In the spring crop under glass (overwintered crop), ten, mainly established selections of the cauliflower cultivars 'Alpha' and 'Mechelse' were trialled. Four trials were carried out with a total of eight replicates. On the basis of yields and crop observations (quality, productivity, earliness and ease of handling), the following selections could be recommended:
'Alpha', 'Kassa', 'Junai', 'Jubro', 'Precassa' and 'Vreugdenhil'.
The trials were sown on 1 October 1982, planted in December 1982 and harvested between the end of March and mid-May 1983.

CULTIVAR TRIAL IN THE AUTUMN CROP *(Cl. Mol)*

In an autumn crop planted on 7 September, ten cultivars were tested for their utility value. The following cultivars could be recommended: 'Dok Elgon' (late harvests) and 'Andes' (early harvests). The other cultivars were less, or not, satisfactory

RUNNER BEANS

EFFECTS OF THE NUTRIENT CONCENTRATION ON THE YIELDS OF RUNNER BEANS IN A SPRING CROP IN NUTRIENT FILM *(Cl. Mol)*

Four EC levels were maintained in the recirculating nutrient solutions used for a crop of runner beans on rockwool, i.e. 2 mS/cm, 4 and later 2 mS/cm, 2 and later 4 mS/cm and continuously 4 mS/cm. There was also a treatment with a periodically circulating nutrient solution (EC = 2 mS/cm) and a temperature treatment of 24^{o} C in the nutrient solution (EC = 2 mS/cm).

Planting out took place on 27 January and the first beans were picked on 16 March. The experiment had to be terminated prematurely as a result of a severe stipple streak virus infection. By 2 May, the yields were highest in the treatment with the continuous 4 mS/cm EC level, i.e. 4.3 kg per m^2 (six plants per m^2). The high root temperature of 24^{o} C had a negative effect on the yields.

BEAN CULTIVAR TRIALS *(J.H. Stolk, M.H. Cools, A.B. Jansen, N.L.M. Stijger and W. de Bruijn)*

Preliminary cultivar trials of climbing runner beans

In the autumn crop under glass, ten runner bean cultivars, including some new cultivars, were tested on two sites in duplicated trials. The standard cultivar 'Helda' was included in the series of ten cultivars. All cultivars were fibreless. On the basis of yield and crop observations (quality, productivity and ease of crop handling), it will be decided in the spring of 1984 which cultivars will be recommended for further trials.

Decisive cultivar trials of climbing runner beans

In the early heated crop, a series of five cultivars was tested in further trials on five sites with at least two replicates. The standard cultivar 'Helda', used for comparisons, was included in the series. The results of three trials and a total of eight replicates could be used as the basis for recommendations to growers. The cultivars 'Super Marconi', 'Hazet-4', 'Femira', 'Florint' and 'Helda' could be recommended with or without qualifications.

BEANS (YARD-LONG)

DAY TEMPERATURES, GROWING SYSTEMS AND PLANTING DISTANCES IN A SUMMER CROP *(Cl. Mol)*

Plant densities and growing systems were studied in a crop of yard-long beans in two glasshouse compartments. The crop was sown on 25 April and planted on 2 May. Ventilation was applied in one compartment at 25^{o} C and in the other compartment at 30^{o} C. The day and night temperatures were maintained in both compartments at 20 and 16^{o} C respectively. The selection '81099', developed by the Institute for Horticultural Plant Breeding, was used as the experimental cultivar.
The planting distances ranged from 30 to 60 cm in the row (2 rows per 3.20 m wide bay) and from 43 to 90 cm (3 rows per 3.20 m wide bay). The number of plants per m^2 was therefore the same for both planting systems and the plan densities ranged between 1 and 2 plants per m^2. The crop was harvested during the period from 2 July to 6 September.

Fig. 7. Yard-long beans

The planting system with 3 rows per bay gave significantly higher early yields than the two row system. The planting distances had no significant effect on the yields. The highest ventilation temperature (30^{o} C) resulted in a higher early yield. However, the percentage second grade was also significantly higher. The average yield of both compartments amounted to 4.6 kg per m^2.

FENNEL

PLANTING DISTANCES FOR FENNEL *(Cl. Mol)*

The yields of cv 'Zefa-fino' were determined for seven plant densities, ranging from 6.2 to 15 plants per m^2. The average stem weight and stem diameter decreased significantly with closer planting. The highest kg yields were obtained at the highest plant density, i.e. 6.8 kg per m^2, compared with 3.7 kg per m^2 at 6.2 plants per m^2.

CULTIVAR TRIALS IN SPRING AND AUTUMN *(Cl. Mol)*

A large number of cultivars was tested for their utility value (i.e. stem quality) in a spring crop (sown on 5 March, planted on 14 April and harvested on 13 June) and a late autumn crop (sown on 27 July, planted on 15 September and harvested on 18 December). The following cultivars were assessed as satisfactory: 'Zefa-fino', 'Sirio' and 'Domino'.

COURGETTE

EFFECTS OF THE BASE DRESSING ON THE YIELDS OF COURGETTES *(Cl. Mol)*

In a spring crop on a commercial nursery, four levels of N:P:K base dressing (12:10:18) were applied, i.e. 0, 5, 10 and 20 kg per 100 m^2. Plants of the cultivar 'Green' were planted on 2 March at distances of 160 x 75 cm. It proved to be difficult to maintain the different levels during the cropping period. The nutrient levels decreased gradually in spite of regular top dressings. The high irrigation frequency (three times per week) did not help matters. At the lowest nutrient level (0 kg N:P:K), N deficiency appeared quite quickly. At a yield level of 37 fruits per m^2 until 14 July, no significant yield differences could be established. The impression was gained that courgettes have a high nutrient uptake, but that from the point of view of yields, only a modest fertiliser dressing is necessary.

PAKCHOY

EFFECTS OF THE PLANT RAISING TEMPERATURE ON THE BOLTING TENDENCY AND YIELDS IN A SPRING CROP *(Cl. Mol)*

During the plant raising period of pakchoy cv 'Japro', sown on 27 December, the following temperatures were maintained: 8, 12, 16, 20 and 24° C. The big differences in propagation temperatures resulted in wide variations in plant habit. Planting out took place on 28 January, at 16 plants per m^2. During the harvest on 14 March, not a single bolter was found. The propagation temperature of 16° C resulted in a significantly higher head weight than the other treatments. The average head weight was 400 g.

EFFECTS OF THE PLANTING DISTANCES ON THE YIELDS IN A SPRING CROP *(Cl. Mol)*

Plants of cv 'Japro' were planted out on 28 January at five plant densities, ranging from 11 to 25 plants per m^2. The harvest took place on 14 March. Since there was a wide variation between the replicates, no significant effects of the planting distance on the kg yields per plot could be established. The head weight, averaged over all the treatments, was 360 g.

EFFECTS OF PLANT SELECTION ON THE YIELDS IN AN AUTUMN CROP *(Cl. Mol)*

A batch of plants ready for setting out, was graded into three lots, i.e. large, normal and small plants. Sowing took place on 1 September and planting out on 19 September at planting distances of 25 x 25 cm. The crop was harvested between 3 and 10 November. There were no significant differences in yields between the three plant grades. However, there was a difference in the plant weights of 100 g per plant on average on both harvest dates, i.e. 330 g on 3 November and 430 g on 10 November.

NUTRIENT CONCENTRATIONS FOR PAKCHOY GROWN IN NUTRIENT FILM *(Cl. Mol)*

A trial crop of pakchoy cv 'Japro' was grown in nutrient film in a specially designed installation. The crop was planted on 10 July. Various EC levels were maintained in the experiment, ranging between 1.9 and 5.7 mS/cm. No significant relationship between the nutrient concentration and the yields could be demonstrated. In one treatment with a periodically circulating nutrient solution, growth was retarded considerably, but as a result of the great heterogenity, the yields did not differ significantly from those obtained in the other treatments. The weights at harvest ranged between 220 and 250 g per head.

CULTIVAR TRIALS IN A SPRING AND AN AUTUMN CROP *(Cl. Mol)*

The utility value of several cultivars was investigated in a spring crop (sown on 27 December, planted on 28 January and harvested on 14 March), as well as in an autumn crop (sown on 1 September, planted on 19 September and harvested on 4 November). The planting distances were 25 x 25 cm, giving 16 plants per m^2.
In both trials, good results were obtained with a selection of 'Spoon-Pakchoi' (sel. 'Clemo'). This selection, developed by the Institute for Horticultural Plant Breeding, produced white upright leaf stems with dark green laminae. The standard cultivar 'Japro' was less satisfactory in these trials (too heterogeneous and the leaves were too feathered).

CHRYSANTHEMUM

DIFFERENT PIPE HEATING SYSTEMS IN THE CHRYSANTHEMUM CROP *(A.P. van der Hoeven and G.P.A. van Holsteijn)*

Following on the investigations conducted in previous years (see Annual Report 1982, p. 80), experiments were carried out with various pipe heating systems, with or without the use of thermal screens. The following systems were tried:

compartments 1 : heating with pipes suspended above the crop, plus the use of one thermal screen,

compartment 2 : heating with low level narrow bore pipes within the crop, plus the use of one thermal screen,

compartment 3 : as in compartment 2, but without a thermal screen,

compartment 4 : as in compartment 2, but with two thermal screens.

There were no differences at harvest between compartments 1, 2 and 3, with regard to stem length, stem weight, number of flowers per stem and average flowering date. In compartment 4, the flower stems were about 10 % longer and heavier and flowering was a few days later.

EXTENDED PROPAGATION PERIODS FOR CHRYSANTHEMUMS *(A.P. van der Hoeven)*

Chrysanthemum growers have been using plants in soilblocks in recent years. The young plants are usually planted out after a rooting period of about two weeks. It might be possible to extend the propagation period and produce larger plants for planting out which would shorten the cropping period in the growing houses. Plant raising experiments were carried out on three commercial nurseries in order to determine the possibilities of this method and to study the effects of an extended propagation period on the crop.

In January, unrooted cuttings were inserted on three nurseries in soilblocks of 3.5, 4.0 and 5.0 cm and in trays (i.e. bedding plant cell trays, referred to below as ppp). The planting distance in ppp was 6 cm. Plants of the different batches were planted out at 2, 3, 4 and 5 weeks after the cuttings were inserted. The observations made during the propagation period showed that plant weight and plant height increased with extending propagation periods. The increase was greatest in ppp and least in the smallest soilblocks. The variation coefficient decreased during plant raising in ppp, but increased in the soilblocks (less uniform). There was a very significant linear relationship at harvest between plant weight and height on the one hand and the planting date on the other. A later planting date resulted in lighter and shorter stems. This was equivalent to one g less in the stem weight and 0.85 cm reduction in stem height for each day's delay in planting. The results were practically the same on all three nurseries.

Plants raised in ppp were significantly heavier and taller at harvest than those raised in soilblocks. Further research is necessary to establish the reasons for this.

The experiments indicated that there are limited possibilities for extending the propagation period. Other crop treatments, such as the start for short day treatments, will then have to be adjusted to the plant size.

RAPID ROOTING METHOD FOR CHRYSANTHEMUMS *(A.P. van der Hoeven)*

In 1982, the working party for horticultural cropping techniques at Wageningen investigated the possibilities of accelerating the rooting process of chrysanthemum cuttings. It was found that pretreated cuttings, i.e. treated with rooting hormone and stored for ten days at 15° C, rooted quicker than untreated cuttings. Following on this investigation, a rooting experiment was carried out on a specialised chrysanthemum propagation nursery. The factors investigated were cultivars, rooting hormone treatment, storage temperature and storage period.
Unrooted cuttings of cvs 'Cassa', 'Refour' and 'Spider' were stood for ten minutes in a 2 cm layer of water or in water containing 250 ppm indolylbuteric acid (IBA).
Following this treatment, the cuttings were stored at temperatures of 2, 7, 12 and 20° C for 0, 6, 9, 13, 16 and 20 days. After the various treatment periods, the cuttings were inserted in the rooting bench where they were given normal commercial treatment. The cuttings were lifted and assessed 7 and 14 days after insertion.
The hormone (IBA) treatment had a positive effect on the speed of rooting. The cuttings rooted quicker after the longer storage periods and the higher storage temperatures. However, the quality of the cuttings also deteriorated rapidly (leaf yellowing and rot) with storage at high temperatures for prolonged periods. The quality deterioration was less in 'Spider' than in 'Cassa' and 'Refour'. The best results were obtained with cuttings treated with rooting hormone and stored at 12° C for nine days. In the case of 'Spider' good results were also obtained with storage at 17° C for nine days and at 7° C for twenty days.
Chrysanthemum propagators are recommended to try pretreatment of cuttings.

INTERRUPTED SHORT DAY TREATMENTS OF CHRYSANTHEMUM *(A.P. van der Hoeven)*

Interruption of the short day period (SD) is commonly practised in Holland in autumn and winter crops. The purpose is to improve the quality of the flower stems at harvest. In practice, the results of SD interruption can be very changeable (see Annual Report 1982, p. 82). It would be an advantage if the factors which affect SD interruption were known. In the summer of 1983, a start was made on an extensive investigation into various aspects of SD interruption. The following factors were included in the experiment: A = the stage at which short day interruption was started, B = plant size at the start of the short day treatment, C = cultivars.
The variants were:
for A : 0, 4, 8, 12, 16, 20, 24 and 28 SD before interruption
for B : 0, 7, 14, 21 and 28 days between planting out and the start of SD

for C : cvs 'Spider' and 'Delta'.
The short day treatment was started in all treatments on 5 May. In every treatment, the interruption consisted of 10 long days (LD).
Without SD interruption, the crop flowered earliest. The chrysanthemums flowered later, the earlier the interruption period was initiated. The early SD interruption treatments resulted in a certain deviation in the flower truss habit. It was quite obvious which of the buds had been initiated before the interruption treatment and which had been initiated after the treatment. The latter also developed leaflets below the buds. The deviations in the flower sprays were the result of the differences in the time of flower bud initiation. The symptoms were most pronounced where the interruption treatment was given after 8 and 12 SD. In the case of cv 'Spider', there was also secondary extension growth. In the treatment where interruption was applied after 4 SD, many plants of cv 'Spider' had not even initiated a crown bud yet. In the case of the smallest plants (factor B - 0 and 7), bud initiation was much slower than in the larger plants.
Bud initiation in cv 'Delta' was much better, quicker and more uniform than in cv 'Spider'. The differences in the flower sprays between the treatments were recorded photographically. Significant effects of factors A, B and C on the results of the interruption treatment were observed in this experiment. The investigation will be continued in 1984.

CHRYSANTHEMUM CULTIVAR TRIALS *(K. Heidemans and J.H. Stolk)*

Preliminary cultivar trials

Spring crop (year round); Flowering April-May, 1983

A series of 31 cultivars was tested in duplicated trials, with and without short day interruption and growth regulator treatment. The cultivar 'Regoltime' was used as the standard cultivar for comparison. On the basis of yield and crop observations (i.e. response time, growth rate, sensitivity to growth regulators and short day interruption, yields and quality of flowers, leaves and stems), the following cultivars could be recommended for further trial : cvs 'Byoux', 'Cassa', 'Dark Janancy', 'Delta', 'Dollaroid', 'Geniaal', 'Guilderland', 'Ready', 'Regent', 'Zandeel' and 'no. 331'.

Summer crop (year round); Flowering June, 1983

A series of 30 cultivars was tested in duplicated trials with the standard cultivars 'Refour' and 'Regoltime'. The cultivars were grown with and without short day interruption and growth regulator treatments.
On the basis of yield and crop observations, the following cultivars could be recommended for further trial: cvs 'Byoux', 'Capayellow', 'Gander', 'Geniaal', 'Jet Set', 'Memo', 'Pegro', 'Greta Verhage', 'Fill', 'Pink Roulette', 'Tessa', 'Fame', 'Vardia', '81-69', '81-127' and 'no. 71'.

Autumn crop (normal crop); Flowering November, 1983

A series of 24 cultivars was tested with and without stopping and with and without growth regulator treatments. The standard cultivars 'Aglow' and 'Oranje Wonder' were used for comparison. The results will be processed and reported in 1984.

Winter crop (year round crop); Flowering February, 1984

A series of 24 cultivars, including the standard cultivars 'Westland' and 'White Horim', was tested in duplicated trials, with and without growth regulator treatments. The results will be processed and reported in 1984.

FREESIA

EFFECTS OF SHADING ON THE TIME OF FLOWERING, QUALITY AND YIELDS OF FREESIAS IN AUTUMN *(J.C. Doorduin)*

The results of a shading experiment in freesias for autumn flowering were reported in the Annual Report 1982, p. 84. The experiment was terminated in 1983.
The yields increased with decreasing shading and ranged between 152 to 235 flower stems per m^2 net. The highest yields were produced by cv 'Rosalinde' with 286 flower stems per m^2 net, followed by 'Ballerina' and 'Blue Heaven' with 167 and 135 flower stems respectively.
The main flower stems were picked with one lateral and the stem length was the same in all shading treatments, i.e. 52 cm. The differences in stem length between the cultivars were small. The laterals were slightly shorter after heavier shading, i.e. from 49 to 45 cm.
Stem weights increased with decreasing shading, ranging in the main stems from 108 to 123 g per 10 stems and in the laterals from 68 to 78 g per 10 stems. The highest stem weight was produced by 'Blue Heaven' with 145 g per 10 stem, followed by 'Ballerina' and 'Rosalinde', with 113 and 92 g respectively.
The main flower stems of 'Blue Heaven' branched considerably irrespective of the experimental factors. The secondary treatment of 3 weeks at 14^{o} C applied to the corms, resulted in a 20 % reduction in the flower stems and a 9 % reduction in the stem weight.
The conclusion is that better light usage, without making concessions to the soil temperature during the period of leaf and flower initiation, is favourable for both yields and quality.
The freesia corms which had been given a secondary treatment before planting flowered 2½ weeks earlier, but this was at the cost of the quality and yields.

EFFECT OF THE LIFTING METHOD ON THE CORM WEIGHT AND PREPARATION

(J.C. Doorduin)

Freesia crops in winter are lifted immediately after harvest. In recent years, a large part of these crops is lifted and dried with the foliage still on the corms.
At the end of January, three cultivars were lifted, half with foliage and half without, and the corms were dried at 22° C and 70 % r.h. for three weeks. After cleaning, the fresh and dry weights of the corms were determined, which was repeated after 12 weeks' preparation at 30° C and 70 % r.h.
Corms harvested with the foliage were 8 % heavier in weight. The effect of lifting with foliage became relatively less, the heavier the corms were. No differences in the dry matter percentages were found between the lifting methods. After 12 weeks' preparation, there was a significant weight loss of 9.5 % in the freesia corms harvested with the foliage and 11 % in the corms lifted without the foliage.

EFFECTS OF LIFTING TIME AND METHOD ON THE QUALITY AND QUANTITY OF FREESIA CORMS IN SPRING *(J.C. Doorduin)*

Freesia corms in spring are increasingly lifted and dried with the foliage attached. This method is combined with lifting a few weeks earlier than usual with the result that the corm development period as well as the cropping period are also shortened by a few weeks.
From the beginning of May, corms of two cultivars were lifted at various stages starting from a fortnight after the end of the flower harvest until seven weeks after flower harvest. The corms were harvested with and without the foliage and dried for two weeks. The fresh weight of the corms increased by 8 to 10 g per 10 corms per week until the fifth week after the end of flower harvest. Subsequent corm development was relatively slight.
Until the third lifting date, the corms harvested with the foliage had a weight advantage of 8 to 10 g per 10 corms compared with the corms harvested without the foliage. By the fourth lifting date, the differences had practically disappeared and by the next lifting date, the corms harvested without the foliage were heavier.
The conclusion is that early lifting in spring goes at the cost of the corm weight. Lifting freesia corms with the foliage has a favourable effect only if the corms are being lifted (too) early.

MULCHING MATERIALS FOR FREESIAS IN WINTER *(J.C. Doorduin)*

Commercial crops of freesias grown with soil heating in winter are mulched immediately after planting with plastic film or Agryll P 17 (polypropene + UV stabiliser). The effect of the mulch was examined.
Freesias were planted in three glasshouse compartments in mid-February. Two compartments were mulched with Agryll P 17 and anti-condensation film for four weeks and one compartment was used as the unmulched control

The space temperature was set at 10° C and the soil heating was controlled to a soil temperature of 16° C.
The actual soil temperatures achieved during the leaf and flower initiation stages were a little more than 16° C. The average pipe temperatures of the soil heating systems were higher under the Agryll cloth and lower under the anti-condensation film than in the unmulched control.
The freesia crop under anti-condensation film was a bit taller, thinner and weaker in the leaves than in the other treatments. The yields under the anti-condensation film remained 8 % behind those obtained in the control and Agryll cloth treatments, whilst the stem weight was also slightly less favourable. This was the result probably of the rather inferior quality of the crop. No adverse effects of the temporary light interception were observed.

MANIPULATION OF THE SOIL TEMPERATURE VIA THE STEAM DRAINAGE SYSTEM

(J.C. Doorduin)

In the summer of 1982, the negative pressure steam drainage system on a commercial nursery was used as a means of manipulating soil temperatures in a freesia crop. In a section of a glasshouse, attempts were made to reduce the soil temperature by sucking air into the drainage system at times when the air temperature was at least 2° C lower than the soil temperature at that moment.
No differences in soil temperatures were found, nor was there any difference in the time of flowering and the quality of the freesias.

FREESIA CULTIVAR TRIALS *(K. Heidemans and J.H. Stolk)*

Preliminary and decisive cultivar trials

Spring flowering 1982-83

A series of 32 cultivars was planted at the research station in the third week of October in order to assess the possibilities for spring flowering. The cultivars 'Aurora', 'Ballerina', 'Côte d'Azur', 'Escapade', 'Golden Melody', 'Golden Wave', 'Oberon', 'Polaris', 'Royal Blue' and 'Uchida' were added to the series for comparison.
Twenty-one of the 32 freesia cultivars were being tried for the first year. On the basis of yield and crop observations (flower, leaf and stem quality, yields and keeping quality), the following cultivars could be recommended for further trials: 'Adagio', 'Allure', 'Animato', 'Blue Bell', 'Bolero', 'Caravelle', 'Destiny', 'Leda', 'Mirabel', 'Mistral', '4310-B_1', '77-238-A_1', '77-269-1', '297735'and '297704'.
Eleven cultivars were being tried for the second year. The preliminary trials were carried out at Aalsmeer during the previous year. The cultivars 'Excelsior', 'Lorelei', 'Riande', 'Vesta', 'Princess of Wales' and 'Yellow Sea' could be recommended finally, with or without qualifications.

Spring flowering 1983-84

A series of 45 cultivars was planted up at the research station in duplicated trials in October 1983.
The cultivars 'Ballerina', 'Côte d'Azur', 'Escapade', 'Golden Melody', 'Golden Wave', 'Oberon', 'Uchida' and 'White Wings' were added to the series for comparison. Of the 45 cultivars, 30 are in the trials for preliminary assessments and 15 for decisive assessments. The results will be processed and published in 1984.

Preliminary cultivar trials

Summer flowering 1983

A series of 15 freesia cultivars was planted in triplicated trials in February 1983 in order to assess the possibilities for summer flowering. The cultivars 'Carmen', 'Gantello','Golden Melody', 'Himalaya', 'Miranda', 'Rosalinde' and 'Ural' were added to the series for comparison.
On the basis of yield and crop observations, the following cultivars could be recommended for further trials: 'Athene', 'Blue Navy', 'Golden Rocks', 'Iceberg', 'Jessica', 'Lorelei', 'Oberon', 'Princess of Wales', 'Yellow Ballet' and 'no. 7742'.

Autumn flowering 1982

A series of 36 new and 10 standard cultivars was planted in May 1982 in order to assess the possibilities for autumn flowering (see Annual Report 1982, p. 85). On the basis of yield and crop observations the following cultivars could be recommended for further trials: 'Arundel', 'Blue Navy', 'Etna', 'Lippizaner','Marianne', 'Pink Glow', 'White Wings', 'Iceberg', 'Angelique', 'Athene','Butterfly' ,'Golden Rocks', 'Helios', 'Magdalena', 'Pallas', 'Panama', 'Polaris', 'Solidor', 'Ural' and 'Welkin'.

Decisive cultivar trials

Autumn flowering 1983

A series of 20 cultivars (see preliminary trials autumn flowering 1982), was planted up in duplicated trials on two nurseries, with and without soil cooling, together with the standard cultivars 'Aurora', 'Ballerina', 'Cote d'Azur', 'Golden Wave', 'Miranda', 'Oberon' and 'Royal Blue'. The total results will be processed and published in 1984.

ASPARAGUS FERN

PLANT DENSITIES IN ASPARAGUS FERN *(A.P. van der Hoeven)*

A plant density experiment for cut fern was started on a commercial nursery in August 1981. The following treatments were applied in triplicate in the experiment: 19, 25, 31, 37 and 43 plants per m^2 bed area. Following on the three yield recordings carried out in 1982 (see Annual Report 1982, p. 84), the final yield recordings were carried out on 1 March 1983. The fronds harvested were divided into five grades: Extra, First and Second Quality and Long and Short Topped.
The yield figures show that for all the harvesting dates, the yields were higher with closer planting. The treatments mentioned produced total yields of 402, 419, 482, 540 and 611 fronds per m^2 bed area respectively. In this experiment, there were no significant differences in quality between the treatments.
Calculations ofthe estimated auction prices and costs of plant material, labour and marketing showed that at the end of the experimental period, the highest plant density also produced the highest financial yield. However, up to the third harvest, on 5 October 1982, the treatment with 25 plants per m^2 bed area produced the highest yield.

CARNATION

THE EFFECTS OF LONG DAY TREATMENT ON THE FLOWERING AND YIELDS OF CARNATIONS *(A.P. van der Hoeven)*

The results of long day treatment (LD) in commercial carnation crops are often variable. Since the reasons for this are not sufficiently known, an investigation into the factors which may influence flowering of carnations was started at the Naaldwijk research station in 1982. In an experiment, rooted cuttings of the cvs 'Silvery Pink', 'Rodoni', 'Ministar', 'Odeon', 'Sam's Pride' and 'White Sim' were planted in two glasshouse compartments on 8 September. 'White Sim' is a standard carnation, all the other cultivars are spray carnations. Half the area in each compartment was given long day treatment between 14 and 28 January with the aid of incandescent lamps (installed capacity 15 W per m^2) which were lit between 17.00 and 09.00 hours. For observation purposes, the cultivars 'Silvery Pink' and 'Rodoni' were given extra light to stimulate growth during the LD period. High pressure sodium lamps were used (installed capacity 100 W per m^2) between 07.00 and 18.00 hours during the period between 7 January and 2 February. On 20 December, shoots of all the cultivars were examined, the leaf pairs counted and the growing point stage determined. The shoots of all cultivars had 10 leaf pairs or more and nearly all the growing points had been induced (start of bud formation). Weekly observations in cv 'Silvery Pink' showed that the growing points developed more rapidly with than without LD. Extra light during the daytime produced a similar response.
LD advanced flowering in all cultivars.

The extra flower yields obtained by 23 May were 'Silvery Pride' - 75 %, 'Bronze Fairy' - 37 %, 'Sam's Pride' -23 %, 'Queen' - 2 %, 'White Dim' - 19 % and 'Minister' - 17 %. After this date, the advance in flower yields disappeared rather rapidly. By the beginning of August, the yield differences had gone. By mid-November, the total yields of 'White Dim' and 'Sam's Pride' in the LD treatments were 7.5 and 2 % lower respectively than in the treatments without LD. The total yields of the other cultivars were 4 to 8 % higher. Like the LD treatment, extra lighting in the daytime also encouraged early flowering, but it did not influence the LD effect. Of all the cultivars, 'Minister' produced the highest and 'Sam's Pride' the lowest yields (460 and 294 stems respectively per m^2 bed area).

GLASSHOUSE CLIMATE CONTROL

RESEARCH INTO THE POSSIBILITIES OF CROP HEATING *(G.P.A. van Holsteijn)*

Investigations into the effects of crop heating in chrysanthemums were continued during the year under review. The experiments were carried out in four glasshouse compartments of equal size. A thermal screen of polyethylene film was installed in two compartments, a double thermal screen was installed in the third compartment and the fourth compartment was left without a screen. In one of the compartments with a single screen, heating took place via high level pipes (51 mm diam.), in the other compartments narrow bore steel heating pipes (27 mm diam.) were installed amongst the crop.
The purpose of the investigation was to determine whether, when using thermal screens, a larger part of the total heat requirement may be applied via the crop heating system without incurring adverse effects on the growth of the crop. Many of the results obtained in previous investigations were confirmed in this experiment. A high energy saving achieved by crop heating was demonstrated again.
Crop heating had a great effect on the atmospheric humidity. The moisture content of the glasshouse air was 2 to 4 g per m^2 higher, indicating a higher transpiration rate. In the compartment with the high level pipes, the highest relative atmospheric humidity levels were measured amongst the crop. In the compartment with crop heating on the other hand, the highest levels were found near and above the top of the crop. In the compartment with crop heating, many condensation drops were formed on the thermal screen.

HORIZONTAL TEMPERATURE GRADIENTS UNDER THERMAL SCREENS *(G.P.A. van Holsteijn)*

The occurrence of horizontal temperature gradients under thermal screens was analysed on three nurseries. Although the temperature patterns were different on the three nurseries, nevertheless it was possible to find a number of common causes.
When the screen was closed, the differences always increased. The differences also increased with increased heating. The highest horizontal temperature differences measured were between 6 and 10^{o} C. The most important causes of this phenomenon were found to be:

the lack of thermal screens along the gables and glasshouse sides, gaps in the thermal screen, particularly near the gables, and the slope of the screen. The temperature gradients could be reduced by two-thirds with the aid of electric fans (capacity about 30,000 m^3 per hour per 1,000 m^2). The temperature gradients increased if the fans were suspended in the cold areas of the glasshouse. The effect of the fans was small in tall crops and relatively long glasshouses.

THE EFFECTS OF ENERGY-SAVING MEASURES ON THE LIGHT INTERCEPTION OF GLASSHOUSE CROPS *(E.M. Nederhoff)*

There is a great need for more insight into the effects of growing factors such as temperature, light and CO_2, on the growth and yields of glasshouse crops. In cooperation with the Centre for Agrobiological Research at Wageningen, a computer simulation model is being developed - at present only for cucumbers - with the aid of which questions on the effects of cultural measures may be answered in future.
At the Naaldwijk research station, the emphasis in this work is on the quantification of light utilisation by the crop. The amount of light available in the winter months in the Netherlands is very small. Even in summer, the average amount of available light is below the saturation level of the crop. This is demonstrated by the fact that in extremely sunny summers the crop yields are considerably higher than in 'normal' summers. This is caused probably by the light penetration into the crop which makes it possible for the lower leaf layers to contribute towards the photosynthesis of the crop. In this project, a study is being made of the effects of planting distance, crop training system, crop type and thinning on the total light interception, the light distribution, photosynthesis and the growth and yields of the crop. Cucumber plant of cv 'Corona' were planted out on rockwool at two plant densities on 21 February 1983. Four types of observations were carried out:

1. light measurements (until the end of April)
2. crop observations (regularly until the end of June)
3. yield recordings (twice a week until June)
4. environmental recordings (continuously)

The data in 2, 3 and 4 were collected in order to test a computer simulation model for growth and production.
Light measurements were carried out with fifteen radiation meters - solarimeters and PAR meters - which were installed in various places, i.e. outside, in the glasshouse above the crop, under the gutter, under the ridge and at various heights within the crop. Calculations were made to determine the percentages of the available light which penetrated to various levels within the crop. The effects of white reflective film used as a mulch on the soil were also studied. The light measurements were carried out only during periods of uniform cloud cover. In sunny conditions, the radiation meters proved to be unsuitable and instead, a so-called light measuring stick was used, i.e. a black painted lath with white dots at 10 cm apart.

The stick was held horizontally in a crop row and by counting the number of white dots catching the sun, the ratio could be estimated between the leaf surface area receiving sun light and the leaf area in the shade. By repeating the estimates many times, a reliable pattern emerged.

Some results of the light measurements were:

1. Effect of plant density. Four weeks after planting, the crop with a plant density of 2.15 plants per m^2 intercepted a good 13 % more light than the crop planted at 1.4 plants per m^2 (LAI were respectively 3.1 and 2.6). Seven weeks after planting, when the LAI for both crops was practically the same at 3.3, there was little difference in the total light interception and light distribution measured. After eight weeks, the yields at plant density 2.15 were about 4 % higher and after eleven weeks, they were about 3.5 lower than the yields at plant density 1.4. The quality was poorer at the higher plant density.

2. Effect of plant age. Three weeks after planting, about 70 % of the available light was intercepted by the crop planted at 2.15 plants per m^2. In the eighth week, more than 90 % of the light was being intercepted. The total light interception depends on the LAI.

3. Light extinction coefficient. The light distribution depends on the distribution of the leaf density. The light intensity in a crop row decreases exponentially from the higher to the lower levels. The extinction rate conforms with the theorem of Lambert Beer and it is possible to calculate an extinction coefficient. This is necessary for computer simulation. The values found - 0.66 to 0.83 - were slightly higher than the values reported in the literature.

4. Direct light. The percentage direct sunlight which penetrated freely through the leaf canopy of a mature crop, varied between less than 5 and more than 10 %.

5. *Reflection.* The light which penetrated to the ground in a mature crop was reflected five times as much by clean white reflection film as by black film mulch (measured in diffuse light conditions).

6. Effect of position in the glasshouse. There were no demonstrable differences in the interception of available light between the rows under the gutters and the rows under the ridge. (Available light is the amount of light in an empty glasshouse).

7. *Simulation.* A first attempt to simulate light distribution (with a model supplied by the Department for Theoretical Production Ecology at Wageningen) yielded a reasonably good correlation with the measurements.

PHOTOSYNTHESIS MEASUREMENTS *(E.M. Nederhoff)*

Also in this project, photosynthetic measurements are carried out in the glasshouse. Knowledge of the air exchange rate of the glasshouse is necessary for the determination of photosynthesis.

In 1983, work was carried out on the development of an on-line and accurate method of measuring ventilation. This is now done with a gas analyser (MIRAN) which measures the concentration of an inert tracer gas (laughing gas N_2O).

The equipment consists of the MIRAN, a data logger (HP), a system for inserting the tracer gas, a vacuum system for the glasshouse air and an anemometer.
A CO_2 meter can also be coupled to the datalogger which makes it possible to determine the CO_2 uptake by the crop with corrections for the CO_2 exchange with the outside air.
Several experimental measurements of the photsynthesis of a cucumber crop were carried out, but the results are not available as yet.

METHODS OF MEASURING VENTILATION RATES IN GLASSHOUSES *(M. Goedhart)*

During the past year, the installation of equipment for measuring ventilation rates was completed. The method was tested in glasshouse compartments of up to 180 m^2 and reproduceable results were obtained for various wind speeds.
The method is based on the principle of estimating ventilation rates with the aid of a tracer gas, in this case N_2O, or laughing gas. The concentration of the N_2O is measured on-line by an infra-red gas analyser. The data are sent to an HP-85 microcomputer for either immediate processing or storage on tape. The measurements of other factors such as wind speed and the N_2O flow can be recorded via a scanner/digital voltmeter unit.
The ventilation rates may be estimated in two ways:
1. The decay rate method. The N_2O concentration is brought up to a certain level and then the N_2O supply is switched off. The ventilation rate can then be estimated on the basis of the decrease of the N_2O concentration over a given time. The ventilation rate thus found is valid for the average wind speed recorded during the measuring period.
2. The continuous flow method. The N_2O flow is maintained at a constant level during the measuring period. When the concentration is in balance in a certain period, the ventilation rate can be calculated on the basis of the concentration, the N_2O flow and the contents of the glasshouse. The ventilation rate thus found is valid for the average windspeed in the period during which the N_2O concentration is in balance. The advantage of the continuous flow method is that thebehaviour of the ventilation rates as a result of changing factors, such as opening of the ventilators, can also be studied. The disadvantage of the continuous flow method, as compared with the decay rate method, is that it can take a long time before a state of balance is achieved in the N_2O flow rate. During periods of rapidly changing wind speeds, it may even happen that no balance is achieved at all.

THE DEVELOPMENT OF ALGORITHMS FOR COMPUTER CONTROL OF GLASSHOUSE CLIMATE *(G. van Steekelenburg)*

Simulation of glasshouse climate control

A simulation programme was developed in order to save time in testing new control programmes. An advantage of testing by simulation is that the glasshouse control system is not disturbed since the simulation is done on another computer and not on the climate control computer.

Disadvantages are that there is no link between the two computers and that the climate model has a limited validity which results in deviations in the simulated conditions.

Structure of the programme

The programme is written in FORTRAN IV for a PDP 11/44 computer under RSX-11 M (DEC). It consists of a basic component and three exchangeable 'blocks'. The basic component controls the simulation (starting, stopping, etc.) and also takes care of the presentation of the results and a number of other user services. The functions of the blocks are:

1. generation of weather signals
2. control programme
3. glasshouse climate model

The climate model is a semi-continuous model of the glasshouse temperatures as presented in the thesis of A.J. Udink ten Cate: Modeling and (adaptive) control of greenhouse climates (Agricultural University, Wageningen, 1983).

Using the programme

The simulation is controlled by means of commands, which means that the user is not bound to follow a fixed order for the simulation. Output may be obtained in the form of tables or graphs, if necessary combined with the output of a previous run, which makes immediate comparisons possible. The use of the commands and changes in the parameters are a simple and flexible process, both for the beginner and the more experienced user.

Manuals

Two manuals for the operation of KASSIM are available. 'Use of simulation programme KASSIM' is a manual for simulation with the existing programme. The use of the climate model is described in an appendix. 'Construction of simulation programma KASSIM' supplies information on the construction of a new programme with other blocks, such as directions for the structure of these blocks, real-time structure of the total simulation, etc.

Glasshouse climate control

The glasshouse climate model consists of a semi-stationary and a dynamic (incremental) part. Inputs are the semi-stationary and incremental components of radiation, wind speed, outside temperatures, ventilation and pipe temperatures. The dynamic part is important for the control technical aspects of the controller and the glasshouse climate to be controlled. By adding the semi-stationary glasshouse temperature to the dynamic glasshouse temperature, a signal is obtained which is comparable with a physical glasshouse temperature.

The semi-stationary component is also of techical importance in the transition from one level to another, since the controls for this may become saturated, i.e. completely open or closed, for example. The level transitions take place during day and night as a result of radiation and/or variations in heating temperatures.

Suitability of the model

In the thesis, a good 'fit' was demonstrated between the simulated and measured temperatures. However, when new measurements were introduced in a simulation, a deviation of several degrees occurred between the simulated and measured glasshouse temperatures. For this reason, the model cannot be used together with a controller in a simulation for the purpose of testing the controller or to determine its optimum setting. A deviation of several degress Celsius would place the controller in a position of saturation.
However, the simulation programme is suitable for qualitative testing, for instance in tracing faults in the algorithm of a controller or its components.

MOISTURE LOSS FROM THE GLASSHOUSE BY VENTILATION AND CONDENSATION

(J.C. Bakker)

During the winter months, the moisture loss via ventilation and condensation was compared with the transpiration of the crop. It was found that over a longer period of time, there was a very good relationship between the total moisture loss and crop transpiration.
The condensation model used has to be developed further yet in order to make it possible to comparte the total moisture loss over short periods with the transpiration of the crop.
An experiment with rapid opening of the ventilators has shown that it is possible (on a short term basis) to estimate crop transpiration from the moisture loss by ventilation and condensation and the changes in the relative atmospheric humidity of the glasshouse.

7. DEPARTMENT OF ECONOMICS AND MANAGEMENT

J.C.J. Ammerlaan

ORGANISATION AND WORK STUDIES

THE EFFECTS OF PLANTING AND CROP SUPPORT SYSTEMS ON THE PHYSICAL AND LABOUR REQUIREMENTS IN CUCUMBER CROPS *(A.T.M. Hendrix)*

The collection of process data was continued. The data found previously (see Annual Report 1982, p. 90) were confirmed, which means that the labour requirements of crop maintenance are now considerably less than they were a number of years ago. This also means that all the labour budgets of the past have to be adjusted.
The data collected this year again confirmed the impression that crop protection operations have also become less labour intensive. This is the result of for instance the introduction of predatory mites for the control of red spider mite and the use of other equipment such as fogging instead of spraying equipment. An experiment designed to determine the physical effort involved in operating the pipe rail and monorail system did not show any reliable differences between the two systems. The differences are so small (a few heart beats per minute), that the physical effort required for the two systems may be assumed to be the same.

MECHANISATION IN THE CHRYSANTHEMUM CROP *(A.T.M. Hendrix, A.J. de Visser and J.C.J. Ammerlaan)*

The investigation into various cropping and mechanisation possibilities, carried out by the chrysanthemum mechanisation working group, was completed this year. The final study, already mentioned in the previous Annual Report, p. 89, was supplemented with data concerning the production of chrysanthemum cuttings by growers and the pretreatment of unrooted cuttings. The study showed that it is an attractive proposition for growers to produce their own cuttings. The treatments necessary for unrooted cuttings have only a very slight effect on the financial results of a business. The main reason for this is that only a small area is required on a nursery for rooting the cuttings. It follows that the profits which may be obtained from home production of cuttings are also relatively small.
The pretreatments for cuttings are probably of greater interest for the large specialised cuttings propagators.
All the studies carried out so far indicate that the rapid cropping programme produces better financial results than the cropping programme which is geared to the production of quality.

COMPARISON OF TOMATO GROWING SYSTEMS *(A.T.M. Hendrix)*

A report was compiled on the economic aspects of the various growing systems currently in use in this crop. The final conclusion reached is that the high wire system produces the best financial results.

TASK TIMES FOR CUT FLOWERS *(A.T.M. Hendrix)*

An investigation was carried out into the labour requirements of harvesting and packing gerberas. The data were converted into task times. The results of the investigation show that:

- harvesting the flowers in a single row system (picking one row at a time) costs more labour than harvesting in a double or triple row system.
- the triple row system is the quickest where up to about 2 flowers per m^2 have to be harvested.
- harvesting more than 2 flowers per m^2 is quickest in the double row system.
- the use of a monorail may provide an attractive labour saving except where the yields are very low, i.e. less than 0.75 flowers per m^2.
- there is a very close relationship between the yield and the harvesting time required per unit product. Higher yields reduce the labour requirements per unit product. The relationship is reciprocal.
- in the present range of cultivars, there are several which require significantly more labour for harvesting than others. For example, 'Pimpernel' and 'Clementine' are more difficult to harvest than 'Fleur' and 'Appelbloesem'.
- the size of the flower bunch has a great effect on the labour requirement. Larger bunches (about 30 flowers per bunch) require less labour than small bunches (about 15 flowers per bunch).

In the packing of the flowers (inserting the flowers into the insets and suspending them in water), labour organisation has a great effect on the labour requirement. Dividing the operations of inserting the flowers and suspending the full cartons in water between different workers nearly always results in substantial time losses. The operations should preferably be organised on an individual basis, i.e. the same person should insert the flowers and suspend them in water. This way there is no risk of waiting time losses and it also opens up the possibility of trimming several full cartons at the same time which provides an extra labour saving.

On the basis of the task times and process data, a labour budget for the gerbera crop (one year's crop with summer planting) was compiled. The budget shows that the total labour requirement for the crop is about 6,000 hours per ha, of which about 65 % is required for harvesting and subsequent treatments of the flowers.

The processing of the data on the rose crop was continued, but because of the large amount of data and variants, the work has not yet been completed.

Data were collected on the labour requirements for harvesting and subsequent treatments of carnations and spray carnations. They have not yet been analysed.

ECONOMICS ANALYSES OF NEW DEVELOPMENTS IN RESEARCH AND PRACTICE

YIELD LEVELS OF NURSERIES WITH SUBSTRATE CROPS *(A.J. de Visser)*

The yield levels of tomatoes, eggplants and sweet peppers on nurseries which have changed over to growing in substrates were compared with the yield levels obtained in soil-grown crops.
In tomatoes the yield levels increased by about 15 %, in sweet peppers by about 20 % and in eggplants by about 30%.

LINEAR PROGRAMMING OF MINOR CROPS *(P.C.M. Vermeulen)*

In order to gain insight into the possibilities of linear programming for minor vegetable crops, a model was designed for radish.
The labour patterns of 104 cropping programmes were studied for a glasshouse nursery of 6,000 m^2.
LINDO, the new linear programming scheme designed by the Agricultural University at Wageningen, was used for the model.

GLASSHOUSE UTILISATION *(J.C.J. Ammerlaan, A.T.M.H. Hendrix and A.J. de Visser)*

Various aspects of extending the plant raising period of a number of important glasshouse vegetable crops, grown in substrates, such as tomatoes, cucumbers, sweet peppers and eggplants, were investigated by the glasshouse utilisation working group. Particular attention was given to the economic, technical and labour aspects.
The study showed that the results of extended plant raising periods were very promising, especially with earlier sowing dates and the same planting dates. The advantages calculated were such that they seem to warrant further investigations into the technical aspects.

DEVELOPMENT AND AUTOMATION OF ADVISORY SYSTEMS

THE COLLECTION AND DEVELOPMENT OF QUANTITATIVE INFORMATION FOR THE GLASSHOUSE INDUSTRY *(J.K. Nienhuis)*

The availability of topical quantitative information is essential for the operation of advisory systems. A start was made therefore on the collection, processing and compiling of such information.

The project is being carried out in cooperation with the Aalsmeer Research Station.
The booklet published contains the follwing chapters:

1. General branch information
2. General nursery business information, which includes the costs of primary and secondary production factors as well as an indication of the replacement values of several types of nurseries and the annual costs derived from these figures.
3. Budgets for a number of vegetable, cut flower and potplant crops.

MANAGEMENT RESEARCH

MANAGEMENT RESEARCH *(J.C.J. Ammerlaan and J.K. Nienhuis)*

Following the publication of the research report on the level of management in the glasshouse industry, the results were publicised further by means of meetings and articles in the trade press.
In consultation with the advisory service, it was decided to investigate whether the survey used in the research project could form the basis for management advice to individual growers.

MANUAL BUSINESS RECORDING *(J.K. Nienhuis)*

In consultation with the advisory service, a new business records book was developed for the glasshouse industry.
About 6,000 copies of the book were published and distributed over the country in cooperation with the NTS and the Rabobank.

AUTOMATION OF BUSINESS RECORDINGS *(J.C.J. Ammerlaan, M. Joosten and P.C.M. Vermeulen)*

An automation project was started in cooperation with the NTS and the auction organisations. The purpose is to promote the uniformity in the development of business recording programmes. It is assumed that the programme is being used in the grower's microcomputer.
Thrity microcomputers will be included in the project in several stages. The initial starting points were formulated at the beginning of 1983 after contacts were made with potential computer programme suppliers. Next, a memorandum was issued in which the business recording systems was described and the relationships with other aspects of business management were indentified. Minimum conditions for the microcomputer were also formulated. At the end of the year, the first eight computers were installed on the same number of nurseries.

8. DEPARTMENT OF PESTS AND DISEASES

L. Bravenboer

VIRUS DISEASES

TOBACCO MOSAIC VIRUS IN SWEET PEPPER *(A.T.B. Rast)*

Freshly harvested seed from diseased sweet pepper plants, infected with either of the pepper strains 1 or 2 of TMV (represented by the isolates P 11 and P 8 respectively), was heated in an oven at 70° C for three, five or seven days. The five days' treatment proved to be sufficient for complete disinfestation.

Fresh batches of seed from healthy or diseased plants were either left untreated, or were first dried in an oven at 40° C for one week and then heated at 70° C for another week, or they were directly heated at 70° C for one week. When sown three months later, there were no differences in germination, neither between seeds from healthy and diseased plants, nor between treated and untreated seeds.

Fresh batches of seed, collected in late autumn from six pepper cultivars grown in a variety trial on a commercial holding, were heated in an oven at 70° C for one week. Sown immediately afterwards, the treated seeds showed poor and irregular germination with a delay of approximately five days as compared to untreated seeds. Differences in sensitivity to heat treatment between cultivars were observed.

Two isolates of TMV, causing yellow mosaic symptoms in sweet pepper, were used for a study on the effects of a repeated passage through Capsicum frutescens 'Tabasco' on their pathogenicity towards tobacco, tomatoes and other test plants. The original isolates caused local necrotic lesions and occasionally some systemic necrosis in 'Tabasco'. Using such systemic infections to start a series of successive transfers to 'Tabasco' resulted in sub-isolates which caused only mosaic symptoms. The sub-isolates obtained were obviously less virulent than the original isolates in Nicotiana tabacum 'Samsun' and Petunia nyctagyniflora and, whereas one sub-isolate still caused symptomless infection in Lycopersicon esculentum, the other had apparently lost this capacity.

TOBACCO MOSAIC VIRUS IN TOMATO *(A.T.B. Rast)*

Three isolates of tomato mosaic virus (ToMV), which were assumed to contain both strains 1 and 2, were each subjected to selection pressure by repeated passage through 'CStMW-18' (Tm-1/Tm-1) and 'Pérou-2' (Tm-2/Tm-2) respectively in concurrent series. Sub-isolates typical for strains 1 and 2 were obtained by this method for each of the original isolates. Further passage of sub-isolates from 'Pérou-2' through 'GCR 254' (Tm-1/Tm-1. Tm-2/Tm-2) resulted in strain 1.2 for two out of the three sub-isolates used. No such 'hybridisation' occurred with the sub-isolates from 'CStMW-18'.

TOBACCO MOSAIC VIRUS IN EGGPLANT *(A.T.B. Rast)*

The TMV isolates A 1 from eggplants and FO from pepper, although serologically indistinguishable, were different in the reactions on a number of test plants (Tóbiás et al., 1982, Neth. J.Pl.Path. 88: 257-268).
It was found that passage through different hosts induced changes in virulence in both isolates, so that they made a better match in host reactions. A 1 usually causes a systemic necrosis in the eggplant cv 'Black Beauty', killing the plants in two weeks. A few passages through the hot pepper cv. 'Westlandia' decreased the virulence of A 1 to 'Black Beauty', in which local necrotic lesions were formed prior to a considerably delayed systemic necrosis. FO initially caused only local necrotic lesions in 'Black Beauty'. After a few passages through Plantago major, FO had increased in virulence so that plants of 'Black Beauty' were killed by a rapid necrosis.
Al and FO were assumed to be related to Holmes' ribgrass mosaic virus since both systemically infected Plantago major and Cyphomandra betacea. However, contrary to ribgrass mosaic virus, they could not infect tomato, neither before nor after passage through different hosts.
Professor C. Wetter of the University of Saarbrücken found no serological relationships between A 1 and FO on the one hand and Holmes' ribgrass mosaic virus and two further isolates of this virus on the other.

VIRUS DISEASES IN FREESIAS *(H.J.M. van Dorst)*

Freesias planted on soil infected with leaf necrosis became affected by the disease, whilst lettuce planted on this soil showed lettuce big vein symptoms. Conversely, lettuce planted on soil infected by lettuce big vein became affected by the virus, but freesias planted on this soil did not show leaf necrosis. It was found that Olpidium brassicae, which transmits lettuce big vein virus, does not grow in freesia roots. This may indicate that there are two Olpidium brassicae strains involved. By means of premunition experiments, indications were obtained that the new form of leaf necrosis which in combination with freesia mosaic virus does not lead to the death of affected freesia plants, is not related to the original old form of leaf necrosis which in combination with freesia mosaic virus does cause the death of freesia plants.

VIRUS DISEASES IN CUCUMBERS AND COURGETTES *(H.J.M. van Dorst)*

Melon necrotic spot virus occurred in cucumber crops on many nurseries in the South Holland Glashouse District this year, in soil-grown crops as well as in crops grown on rockwool.
An experiment was carried out in order to determine whether the rootstock Cucurbita ficifolia can be affected by Olpidium cucurbitacearum, the transmitting agent for this virus.

C.ficifolia and cucumber plants were planted out on rockwool slabs infected with melon necrotic spot virus and Olpidium. After a few weeks, the dormant spores of the fungus were found in the roots of both cucumbers and C.ficiolia. The cucumbers also showed melon necrotic spot virus symptoms. Cucurbita ficifolia did not show any symptoms, nor could the virus be isolated from the plants by back inoculation to cucumber plants. This, added to the experiences of 1981 and 1982, leads to the conclusion that the Fusarium resistant rootstocks C.ficifolia, used for grafting cucumbers, is immune to melon necrotic spot virus.

A for Holland completely new virus disease was found in autumn cucumbers on a number of nurseries. The disease occurred at the same time in some courgette crops. The consquences were serious for both crops. Mrs E. van Balen of the Research Institute for Plant Protection at Wageningen has identified the disease as 'Zucchini yellow mosaic virus'. The disease is spread especially by aphids, but some transmission may also take place during pruning and harvesting operations. The source of the disease is still unknown.

VIRUS DISEASES IN LETTUCE *(H.J.M. van Dorst)*

Lettuce big vein virus in lettuce is spread by the zoospores of the soilborne fungus Olpidium brassicae. An investigation was carried out to determine whether the dormant spores (see Fig. 8) occur in the drainage water and whether the disease may be spread via the surface water. On a number of nurseries affected by lettuce big vein as well as ring necrosis virus, samples of the drainage water were collected when the soil was flooded after the lettuce harvest. After treatment in the centrifuge, the concentrate was applied to the susceptible test plant Solanum villosum and to young lettuce plants. It was found that Olpidium is spread very readily by the drainage water and is capable of causing re-infections with lettuce big vein and ring necrosis (see Fig. 9) in this way.

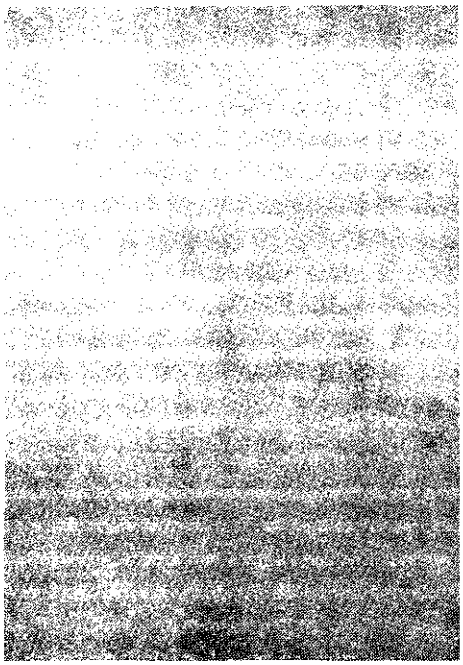

Fig.8 Dormant spores of Olpidium brassicae in a lettuce root

Fig.9 Lettuce ring necrosis

FUNGAL DISEASES

PHOMA DESTRUCTIVA IN TOMATO *(N.A.M. van Steekelenburg)*

Last year, it was established in a spring crop that inoculation of the main stem in 2 and 4 places had no effect on the extension growth of the plant or on its yields (see Annual Report 1982, p. 97). The experiment was repeated in an autumn crop of fleshy tomatoes and on this occasion the number of inoculation sites per plant was increased to 8. Again, no significant differences in extension growth and yields between the treatments were found.

DIDYMELLA BRYONIAE (MYCOSPHAERELLA CITRULLINA) IN CUCUMBER

(N.A.M. van Steekelenburg and G.P. Verduyn)

Internal fruit rot

It was found that allowing fruits to develop after flower inoculation, resulted in 25 to 70 % of the fruits becoming internally affected, depending on the inoculation date. It has been reported in the literature that materials such as sucrose, glucose, yeast extract and caseinehydrolysate,added to the inoculum suspension, will promote leaf infection. An investigation was carried out to determine whether this is also true for internal fruit rot. However, no positive effect of these additives could be established. In the case of the cultivar 'Millio', which is resistant to powdery mildew, the number of internally affected fruits following flower inoculation was 38 % less than in 'Farbio' which is susceptible to powdery mildew.

Effect of the climate

The effects of the relative atmospheric humidity and the spore concentration on leaf infection were investigated further under controlled conditions by inoculation with drops of conidial suspension applied after wounding (see also Annual Report 1982, p. 96). At a r.h. of 60 % and an inoculation rate of 10 spores per site, there was no, or hardly any, infection. A higher spore concentration increased the infection rate to 20 % at 10,000 spores per inoculation site. At 95 % r.h., the number of successful inoculations ranged between 30 and 90 %, depending on the spore concentration. The degree of infection was also more severe than at 60 % r.h. No difference in infection was obtained whether the plants were placed in the dark or in the light for the first twelve hours following inoculation. Forced drying of the inoculant drops for one hour before the plants were placed at 95 % r.h., did not decrease infection. The rate of infection was not reduced either when wounding and inoculation were carried out simultaneously with the aid of a corkscrew infected with sporal slime straight from an agar nutrient medium. After wounding of the leaf, there is no need for extra free water in order to obtain infection.
The results of the previous year's experiment on the effects of the transition time from night to day temperatures on inoculated and untreated cucumber plants growing under practical conditions, were analysed further.
The transition times were at three hours and one hour before, and at one hour and three hours after sunrise respectively. The inoculated plants of the treatment with a transition time three hours before sunrise produced an average of two lesions per main stem after four weeks. The number increased to eight lesions per main stem in the plants inoculated three hours after sunrise. These differences were evened out completely later on in the season. Inoculation caused a 15 % reduction in the leaf development on the secondary laterals, whilst the number of secondary laterals was increased compared with untreated plants.

With regard to the infection of the growing points of the sub-laterals, no effect of the climate could be found, but there was an effect of the inoculation. The climate had no effect on the yields. Inoculation caused a yield reduction of between 5 and 14 %, depending on the duration of the harvest period and caused also a 15 % increase in the yield of misshapen fruits. The incidence of internal fruit rot increased, the later the transition to the day temperature was made. In the treatment at three hours after sunrise, internal fruit rot occurred three times as often as in the treatment at three hours before sunrise. The climate had no effect on the incidence of external fruit rot but inoculated plants produced three times as many fruits with external rot as the untreated plants.

PITH NECROSIS IN CHRYSANTHEMUM CUTTINGS *(N.A.M. van Steekelenburg)*

The investigation into the incidence of pith necrosis in chrysanthemum cuttings was continued (see also Annual Report 1982, p. 82). Via isolation, inoculation, re-isolation and determination, a cycle which was repeated once more, it was established with the aid of the bacteriological department of the Plant Protection Service that Erwinia carotovora subsp. carotovora is the cause of this disease which occurs during the rooting of chrysanthemum cuttings. Inoculation was carried out by dipping the stem base of the unrooted cuttings into the bacterial suspension. Concentrations of 10^9 or 10^6 bacterial cells per ml suspension did not result in differences in the rate of infection. At a concentration of 10^3 cells per ml, the infection was significantly reduced, but still quite considerable.
Differences in susceptibility between cultivars were found. 'Cassa' was more susceptible than 'Regoltime' and 'Westland'. The possible effect of the nutrition on the susceptibility of the cuttings was studied by growing stockplants in recirculating nutrient solutions with EC values ranging between 0.75 and 6.0. However, the cuttings obtained from the different EC levels did not show any significant diferences in susceptibility to E. carotovora.

FUSARIUM SOLANI IN GLASSHOUSE VEGETABLE CROPS *(S.J. Paternotte)*

Last year, slight differences were found in the susceptibility of Cucurbitaceae to Fusarium solani f.sp. cucurbitae (see Annual Report 1982, p. 99). This is why the effect of the inoculum density on the disease incidence in a number of Cucurbitaceae was studied. The susceptibility to the pathogen decreases from courgette cv. 'Green' to courgette cv. 'Gold Rush', Benincasa cerifera, RS 841 to cucumber cv. 'Farbio'.
Another aspect studied was the effect of the plant type on the disease incidence. An experiment was carried out in which courgette plants were grown in 2 litre pots in fertilised potting compost. Some of the pots were place in mains water in an unshaded glasshouse, others were placed in mains water as well as in a nutrient solution with an EC level of 5.5 in a heavily shaded glasshouse.

The plants were inoculated 1½ months later. The plants raised in the unshaded glasshouse, i.e. the most vigorously growing plants, were the least affected by the disease.
In order to establish whether older plants are able to escape the disease, inoculations were carried out when the plants were 2, 4, 6 and 8 weeks old. The disease symptoms were present on all the plants twelve days later and the only difference was that the younger plants died quicker.
A high percentage of courgette seed was readily infected by the pathogen by injecting a fully developed fruit of cv. 'Green' with a conidial suspension of the fungus. Following external disinfection of the seed with hypochlorite of alcohol, the fungus could still be re-isolated from the seeds six months after harvest, or seven months after inoculation. After that time, it was found to be impossible to isolate Fusarium from infected seeds and from plants raised from the same seed batch which were actually showing necrotic spots on the cotyledons. The germination percentage of this seed batch was 50 % and that of a control batch 95 %.
Isolates of the fungus derived from diseased courgette plants were crossed with each other and with an isolate from cucumbers by the Central Bureau for Fungal Cultures. The dishes were incubated at 25° C in the dark, in daylight at room temperature and in a cabinet set at 20° C and equipped with N.U.V. light. No sexual stage of the fungus has been observed up to now. Isolates of F. solani f.sp. cucurbitae from courgettes are different from isolates of F. solani obtained from sweet peppers, in vivo as well as in vitro (Annual Report 1982, p. 98). Macroscopically, the species are different in vitro with regard to colour and growth habit and microscopically they are different in their spore shape.

PESTICIDES IN SUBSTRATE CROPS *(W.T. Runia)*

Rockwool crop

Several pesticides were tested for phytotoxicity on young cucumber and tomato plants growing in rockwool. Each plant was drenched with half a litre of the diluted pesticide to be tested.
The concentrations of the fungicide etridiazole (liquid formulation) used were: 25, 50, 100, 200 and 400 ppm a.i. Damage occurred from 50 ppm upwards, both in cucumbers and in tomatoes.
The concentrations of the fungicide propamocarb applied were: 175, 350, 700, 1400 and 2800 ppm a.i. Damage occurred from 350 ppm upwards, both in cucumbers and tomatoes. The damage ranged from scorched leaf edges to scorch of the entire leaf surface, depending on the concentration used.
The insecticide and nematicide oxamyl was applied in concentrations of 50, 200, 500 and 2500 ppm a.i. Applications of 200 ppm a.i. or more caused scorch in tomatoes as well as in cucumbers.

Nutrient film crop

The compounds were also tested for phytotoxicity on young sweet pepper and tomato plants growing in a nutrient film system. The compounds were poured into the circulation tank.

In the case of tomato plants, the application of 25 ppm a.i. etridiazole (liquid formulation) did not cause any damage, but the application of 50 or 100 ppm a.i. caused yellowing of the leaf veins. The same concentrations did not cause any damage to the sweet pepper plants.

Concentrations of 175, 350 and 700 ppm a.i. of the fungicide propamocarb caused damage to tomato plants ranging from very light to severe scorch. The sweet peppers showed damage only after application of 700 ppm a.i.

The insecticide and nematicide oxamyl was applied in concentrations of 50, 125 and 500 ppm a.i. 125 ppm caused scorch in tomatoes and at 500 ppm there was damage to sweet peppers.

Runner beans were grown on virus infected rockwool blocks in a recirculating nutrient solution. The spreader nonylphenolpolyglycol ether was added to the nutrient solution in order to curb the spread of stipple streak virus in the runner beans (Helda) by the fungus Olpidium brassicae.

A concentration of 5 ppm a.i. was applied once a week, twice a week and once a fortnight, whilst a concentration of 10 ppm a.i. was applied once a fortnight. The percentage runner beans affected by the disease was 50 % in the untreated control and the percentage was reduced in inverse proportion to the application frequency, with 6 % being affected in the twice weekly treatment.

STEAM STERILISATION OF ROCKWOOL *(W.T. Runia)*

Container steaming

Rockwool slabs (100 by 30 by 7.5 cm) without their wrapping were stacked 19 layers high (150 cm) on pallets (100 by 100 cm) with four slabs per layer. Nine pallets were placed in a container after which steam was introduced, supplied by a 500,000 Kcal boiler at a pressure of 0.6 to 0.7 ato. Thermocouples were placed in the wet as well as in the drier parts of the slabs. After 30 to 45 minutes steaming, the temperature differences within the same slab were sometimes as much as 50 or 60^{o} C. However, the temperature reached 100^{o} C throughout the stack after more than one hour's steaming.

Sheet steaming

Temperature measurements were carried out on a nursery where rockwool slabs were steamed with and without their wrapping. The rockwool slabs (100 by 15 by 7.5 cm) were stacked 17 layers high, with six or eight slabs per layer.

A temperature of 100° C was reached at all the measuring points in the slabs without wrapping two hours' steaming. After three hours' steaming, the temperatures in the dry wrapped slabs ranged between 92 and 100° C, and in the wet wrapped slabs between 85 and 93° C. During a second measuring session on this nursery, only wrapped slabs were being steamed. A layer of wet slabs with thermocouples was placed in the middle of the stack, the other slabs were dry. After three hours' steaming, the temperatures in the dry slabs ranged between 64 and 100° C, depending on the distance from the steam inlet. The temperatures were highest in the bottom and top layers in the stack and they were lowest in the middle. The two measuring points in the wet slabs reached temperatures of 33 and 58° C respectively. The poor temperature distribution in the stack, horizontally as well as vertically, was caused by tight stacking which prevented rapid penetration by the steam. The gas usage for steaming amounted to 0.07 m^3/m^2.
Temperature measurements were also carried out in rockwool slabs (100 by 20 by 7.5 cm) on another nursery. The wrapped slabs were stacked 12 layers high on pallets, with four or five slabs per layer. Spaces were left between all the slabs for maximum steam penetration. When the steam supply was shut off after five hours, the temperature was 99 to 100° C throughout the stack. Gas usage amounted to 0.13 m^3/m^2.

DISINFESTATION OF ROCKWOOL SLABS IN A MAGNETRON OVEN *(W.T. Runia)*

Rockwool slabs, infected with cucumber green mottle virus (CV-2), were placed in a magnetron oven for various periods. The magnetron was set for a useful capacity of 560 W. The rockwool slabs (10 by 15 by 20 cm) were placed on a sheet of glass in order to obtained a good heat distribution. The heat exposure times applied were 10, 20, 30, 60 and 90 seconds. A temperature of about 100° C was obtained in the middle of the rockwool slab, with 50° C on the outside of the slab.
Next, the slabs were moistened with 1.5 litres water (50 vol. %), the moisture was pressed from the blocks and used to inoculate the leaves of young cucumber plants (cv. 'Sporu'). Ten plants were used for each treatment. The percentages of diseased cucumber plants were as follows: untreated control (disease free rockwool) - 0 %, untreated control (infected rockwool) - 100 %, 10 and 20 seconds heat treatment - 100 %, 30 seconds heat treatment - 90 %, 60 seconds heat treatment - 20 % and 90 seconds heat treatment - 50 %.

STEAM STERILISATION OF SOIL *(W.T. Runia)*

Temperature measurements were carried out on a nursery on reclaimed moor, where negative pressure steaming was being used via open-ended polypropene drainage pipes buried at a depth of 90 cm and at a distance of 3.20 m between the pipes (the width of a glasshouse bay). Although the soil had been dug over to a depth of 70 cm, the temperatures at 30 cm depth remained between 47 and 100° C, depending on the distance of the measuring point from the pipe.

It was found that the drainage pipe was not far enough above the level of the ground water table which meant that ground water was being taken up during the steaming process cancelling out the negative pressure.

Soil steaming and the yields of chrysanthemums

In cooperation with A.P. van der Hoeven, an investigation was started in November 1982, in which the following treatments were carried out on four nurseries (one on light loam, two on heavy loam and one on clay): 0 hour, 1 hour and 6 hours steaming, part of the latter treatment combined with soil cultivation. Yield observations (stem length and stem weight) were made during the harvests of the first, second and third crops. Other aspects studied were the keeping quality of the flowers in the vase, Mn water and Mn crop, the bromide contents of the soil and the percentage dry weight of the crops. No clear necessity for steaming for the benefit of the yields could be demonstrated. Only the flowers harvested in the second crop on the clay soil had a significantly lower stem weight on the untreated soil than on the steamed soil. Soil cultivation before steaming is not desirable since it may damage the soil structure.
One reason for soil steaming may be the presence in the soil of certain pathogens such as Verticillium, Sclerotinia, white rust or leafminers. Steaming may also be desirable for the decomposition of chrysanthemum debris of the previous crop. No differences were found between the treatments with regard to keeping quality, percentage dry weight and the bromide contents in the soil. The Mn contents in the crop at harvest were higher, the longer the steaming treatment was applied. In general, there was an increase in the Mn levels of the water following steaming, but they were no reason for disquiet on any of the nurseries. By harvest time, the Mn levels of the water had decreased to very low values, or even to nihil

CONTROL OF BOTRYTIS AND RHIZOCTONIA IN LETTUCE *(M. van der Staay)*

Research was carried out into the possibilities of applying the compounds furmecyclox, tolclofos-methyl and dichloran/captan separately, or in combination with iprodione or thiram. The possibility of applying iprodione as a soil treatment before planting out was also examined.
It was found that the various compounds used separately resulted in inadequate disease control. Thiram, used on its own at a rate of 0.8 g a.i. per m^2, gave the best results still.
Furmecyclox, used as a soil treatment at 0.8 g a.i. per m^2 and tolclofos-methyl as a soil and crop treatment at 1.5 g a.i. per m^2, combined with iprodione at 0.2 g a.i. per m^2, or thiram at 0.8 g a.i. per m^2, gave good results. The results were slightly less favourable with the combination of dichloran/captan at 0.96/0.72 g a.i. per m^2.
The application of a soil treatment with iprodione at 0.5 g a.i. per m^2, followed by a crop treatment with iprodione at 0.2 g a.i. per m^2 or thiram at 0.8 g a.i. per m^2, was found to be unsuitable for commercial use.

The treatments gave only a modest level of disease control. The combination of soil and crop treatments with iprodione produced the same results as a crop treatment alone. The best results were obtained with the combination of iprodione and thiram, at 0.2 and 0.8 g a.i. per m^2 respectively, applied as a spray after planting out.
The investigation comparing low volume misting with spraying of iprodione at concentrations of 0.2, 0.15, 0.075 and 0.025 g a.i. per m^2 was completed. The conclusion was that both in spraying and in low volume misting with the special formulation, good results were obtained only with the highest application rate. Less fungicide per m^2 immediately resulted in a higher disease level.
With low volume misting using spray powder in water, only the lowest concentration gave inadequate disease control. The other application rates all gave similar results which were comparable with the results obtained from the highest rates of the other two methods. This showed that it is possible to still obtain good results with less active ingredient per m^2.

PESTICIDE SPRAY COVER AND PENETRATION INTO THE CROP *(M. van der Staay)*

As in the previous year (Annual Report 1982, p. 100), residue analyses were carried out on lettuce to determine where a compound is deposited on the plant and whether this is reflected in the results obtained in the control of Botrytis and Rhizoctonia. The compound used was iprodione.
The residues on the leaves and stems were determined separately, immediately after the sprays had been applied and also after the crop had been irrigated once in order to determine the possible redistribution of the compound. The conclusion was the same as that reached in 1982. With spraying, the larger amount of liquid tends to settle on the stem and after irrigation hardly any redistribution takes place. With low volume misting, using a special formulation or spray powder in water, the smaller quantity of liquid caused a lot of the compound to remain on the leaves where it was deposited. Irrigation did not cause any redistribution of the special formulation product, but some redistribution took place in the case of the spray powder in water. The importance of this in the control of Botrytis and Rhizoctonia is not quite clear as yet.
The residue analyses were carried out by the Central Institute for Nutrition and Food Research at Zeist.

THE SUSCEPTIBILITY OF PREDATORY MITES TO PESTICIDES *(M. van der Staay)*

Phytoseiulus persimilis

Two fungicides - bitertanol and fenarimol - were tested in a laboratory experiment for their effect on Phytoseiulus persimilis. Both compounds are used in the control of mildew in cucumbers.

The LD 50 for bitertanol was around 10,000 mg a.i. per litre (the rate used by commercial growers is 300 mg a.i. per litre) and the LD 50 for fenarimol was about 500 mg a.i. per litre (commercial rate 60 mg a.i. per litre) . Both compounds may therefore be used without any problems in an integrated control programme for cucumbers.
The susceptibility of Phytoseiulus persimilis to organo-phosphorous compounds was tested in a laboratory experiment. Since about 1973, the horticultural industry has a predatory mite available which is resistant to this group of compounds. The resistance was found to be unchanged.

Amblyseius cucumeris

Several pesticides were tested under semi-laboratory conditions for their effect on A. cucumeris. The susceptibility of A. cucumeris to organo-phosphorous compounds was very great and comparable with that of P. persimilis in the past. The same applied to the acaricide dicofol. The total insusceptibility to the acaricide fenbutatinoxide was quite remarkable. The fungicides iprodione and triforine had no harmful effects on the predatory mite A. cucumeris.

THE SUSCEPTIBILITY OF THE WHITEFLY TRIALEURODES VAPORARIORUM TO PESTICIDES *(M. van der Staay)*

The compound NL 4140 (previously R 101618) was tested on whitefly harvested larvae and pupae under semi-laboratory conditions. All stages were treated with three concentrations - 125, 62.5 and 31.25 ppm - and these were compared with an untreated control. The pupal stage proved to be immune to NL 4140, but all larval stages were very susceptible. Even at the lowest concentration, a mortality rate of 100 % was achieved.

THE SUSCEPTIBILITY OF THE INSECT PATHOGEN ASCHERSONIA ALEYRODIS TO PESTICIDES *(M. van der Staay)*

Aschersonia aleyrodis is a fungus used in the control of whitefly, Trialeurodes vaporariorum. By frequent spraying with a sporal suspension, and in combination with the parasite Encarsia formose, this fungus may offer possibilities for the biological control of whitefly in, for instance, cucumbers. The method would be even better for commercial use if it were possible to mix the sporal suspension with a mildewicide. Several fungicides were assessed in germination tests for their activity against A. aleyrodis. Triforine at rates of 200, 400 and 800 g a.i. per litre resulted in no germination of the spores. In the case of bupirimate applied at rates of 250, 500 and 1000 g a.i. per litre, the spores germinated, but the growth of the mycelium was inhibited, more so at the higher rates than at the lower. This was also the case with pyrazofos applied at rates of 100, 200 and 400 g a.i. per litre.

PHYTOXICITY OF PESTICIDES *(M. van der Staay)*

Young plants of cucumbers, tomatoes, sweet peppers and eggplants were sprayed with various concentrations of CGA 72662, Ro 155223 and CME 13406, three insect growth regulators (IGR). The experiment was carried out in early December, the period of the year when the plants are most susceptible to sprays.
CME 13406 did not give any damage. CGA 72662 resulted in a white discoloration of the leaf edges of cucumbers and tomatoes. Ro 155223 caused scorched spots on cucumber and eggplant leaves and malformations of the youngest leaves of sweet peppers.

PESTS

BIOLOGICAL CONTROL OF THE TOMATO LEAFMINER *(J. Woets and A. van der Linden)*

In cooperation with the Koppert company-producers of natural enemies-Opius pallipes Wesmael was released on a number of tomato nurseries, in crops planted in December 1982, for the control of Liriomyza bryoniae Kalt., the tomato leafminer. The pest and parasite patterns were studied until well into the summer period.
In several of the glasshouses, both the pest and the natural predators were found to have survived the winter from the autumn crop. It was also found that the release rates for Opius pallipes should have been much higher than had been deduced from the natural control situations studied in 1980 and 1981 (see Annual Report 1981, p. 103).

BIOLOGICAL CONTROL OF THE AMERICAN SERPENTINE LEAFMINER *(J. Woets and A. van der Linden)*

Tomatoes

Between March and July 1983, an experiment was carried out designed to control the American serpentine leafminer (Liriomyza trifolii Burgess) with the aid of the parasite Chrysocharis parksi Crawford from California.
In three glasshouse compartments with densities of between 100 and 200 mines per plant in the second generation, Chrysocharis were released at rates of 0, 20 and 100 females respectively per compartment containing 170 plants. At the time of release, the compartments contained 25,500, 36,900 and 16,500 mines respectively.
In all three compartments the pest was destroyed within two to three months. In the untreated control compartment, this was the result mainly of the spontaneous occurrence of the ectoparasite Diglyphus isaea Walker. In the two compartments in which Chrysocharis were released, the destruction of the leafminers was achieved mainly by Chrysocharis, supported to some extent by Diglyphys isaea. Dacnusa sibirica Telenga and Opius pallipes Wesmael also occurred spontaneously, but they were not of any importance in the control of leafminer.

In the course of July, a new tomato crop was planted in the two compartments in which Chrysocharis had been released. Although L. trifolii were introduced into the crop, the infestations did not spread very much. The pest was controlled by D. isaea and C. parksi. In August and September, the maximum number of mines amounted to a few dozen per plant (< 20 dead larvae plus < 20 empty mines). After September, hardly a single larva could be found in the crop.

Gerberas

Spontaneous parasitism of Liriomyza trifolii took place in a glasshous with gerbera cvs. 'Veronica' and 'Appelbloesem', planted at the end of June. The parasitism by Diglyphus isaea increased from 12 % at the beginning of August to 72 % at the beginning of September. During the month of August, 10 to 50 new mines per plant were counted every week. The number of larvae killed by host feeding by D. isaea ranged between 8 and 40 per week. By mid-September, the young leaves were free from infestation and no leaf-miners were to be found any more. From then on, for a period of four weeks, endosulfan was sprayed at weekly intervals against straw mite. Tyrophagus putrescentiae. As a result of American serpentine leafminers flying into the glasshouse from outside, the number of mines increased again, but no parasites were found in the larvae.

BIOLOGICAL CONTROL OF APHIDS *(P.M.J. Ramakers and M.J. van Lieburg)*

On a sweet pepper nursery of 1.2 ha, aphids (predominantly Myzus persicae and Aphis sp.) were controlled biologically between April and November by the introduction of the parasite Aphidius matricariae and the predator Aphidoletes aphidimyza. Critical peaks in the development of the aphid population occurred on three occasions. During the second peak in June, a pirimicarb spray was applied which was the only insecticidal treatment in the experiment.
Aphids in sweet peppers in three experimental glasshouse compartment of 20 m^2, were controlled by a single introduction of A. aphidimyza, followed by the periodical addition of aphids to stabilise the system. One sweet pepper plant with Myzus persicae was added per compartment at intervals of 2, 3 and 5 weeks. The frequency of five weeks proved to be inadequate, but the other two treatments produced satisfactory results.

INSECT PATHOGENS *(P.M.J. Ramakers and M.J. van Lieburg)*

Experimental spray applications of Verticillium lecanii (commercial preparate Mycotal) and Aschersonia aleyrodis against whitefly were carried out on some tomato, cucumber and eggplant nurseries. Myctoal failed frequently as a result of unfavourable weather conditions. The best results were obtained after a spray application in October. Aschersonia was succesful only when fresh conidiae were used.
Bacillys thuringiensis was used on several hundreds of nurseries for the control of Noctuidae.

In order to be able to provide recommendations for the use and application rates of Bacillus thuringiensis , it is desirable that the caterpillars can be indentified. A collection was started of the head-capsules of the successive larval stages of the relevant species.

BIOLOGICAL CONTROL OF ONION THRIPS *(P.M.J. Ramakers and M.J. van Lieburg)*

The dynamic interaction between Thrips tabaci and the predatory mites Amblyseius cucumeris and A. mckenziei was studied in detail in cucumber crops, in which no chemical sprays were used with the exception of pirimicarb.
The most important conclusions were: following spot introductions of hundreds of predators on one leaf, most of the predators are lost within a fortnight; in the absence of alternative food sources such as spider mites, a considerable thrips density is required for a positive response from the predator population; thrips control is achieved with a predator density in the order to magnitude of 10 per leaf.
On a nursery with 1.2 ha of sweet peppers in rockwool, where spider mite was controlled with Phytoseiulus persimilis, Amblyseius cucumeris was also introduced before any thrips were found, making use of the presence of spider mites as an alternative prey. On average, over the entire experimental period of more than seven months, the Amblyseius population on the leaves proved to be more numerous, more stable and better distributed than Phtyoseiulus. On the fruits, only Amblyseius were found. The first thrips were found several weeks after the introduction of the predatory mites, but they never reached a density of any importance. There were insufficient thrips present to explain the size of the predatory mite population.
A. aurescens and A. potentillae were isolated from a cucumber crop in which no pesticides had been applied for a long time. Both species could be bred further in the laboratory on Acarus farris.
Attempts were made to improve the breeding of predatory mites on wheat bran with Acarus farris by extracting the CO_2 with sodium lime. The CO_2 level was reduced to far under the natural atmospheric value, but the breeding yields showed no improvement.
In August, a spontaneous infection of Thrips tabaci by Entomophthora parvispora was identified in a cucumber glasshouse. Amblyseius spp. with anadhesive spores on their legs were found frequently, but internally affected predatory mites were never observed.

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10. CROPS INDEX

11. METEOROLOGICAL DATA 1983, NAALDWIJK

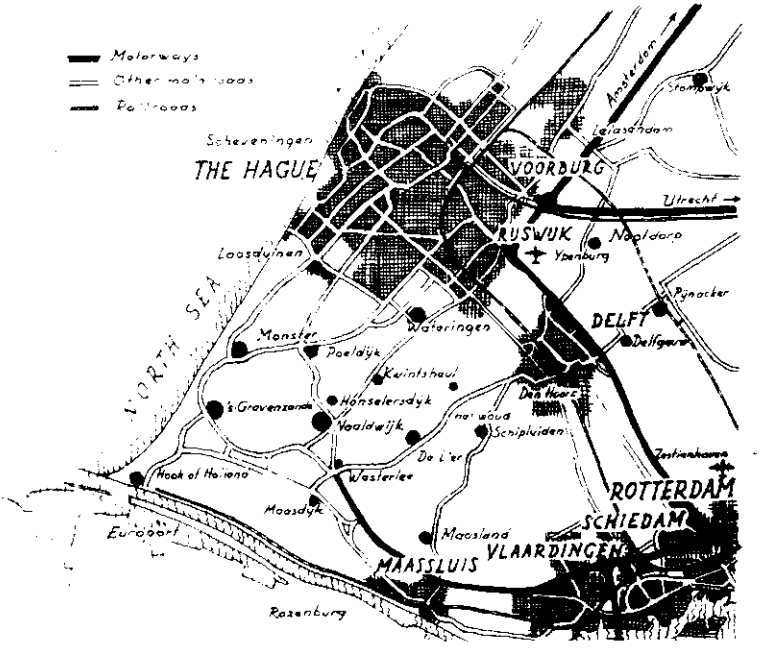
Month	Temperature								Frost	
	mean daily				highest		lowest		no. of days	
	max. °C		min. °C		max. °C		min. °C			
Jan	8.6	(5.1)*	4.7	(0.9)*	13.4	(9.9)*	0.3	(- 6.4)*	0	12.9*
Feb	4.3	(5.6)	- 0.4	(0.8)*	9.7	(11.1)	- 4.8	(- 5.6)*	16	11.0
Mar	8.9	(8.6)	3.9	(2.6)*	14.2	(15.6)	1.0	(- 3.0)*	0	8.3
Apr	12.2	(11.7)	6.2	(5.1)*	19.6	(19.8)	1.9	(0.6)*	0	0.6
May	14.3	(16.0)	8.7	(8.7)*	24.3	(24.6)	5.4	(3.7)*		
Jun	20.1	(19.0)	12.7	(11.6)*	29.9	(27.3)	5.9	(7.1)*		
Jul	24.2	(20.3)	15.2	(13.5)*	30.7	(28.5)	9.9	(9.5)*		
Aug	22.7	(20.6)	14.9	(13.5)*	30.0	(27.2)	11.5	(9.2)*		
Sep	18.0	(18.6)	12.2	(11.6)*	22.0	(25.1)	8.3	(6.5)*		
Oct	14.9	(14.5)	9.1	(8.3)*	25.7	(20.2)	0.5	(2.5)*	0	0.5
Nov	10.5	(9.4)	4.9	(4.6)*	16.1	(14.5)	- 4.5	(- 1.8)*	5	3.7
Dec	10.0	(6.4)	6.6	(2.2)*	12.8	(11.3)	- 2.8	(- 5.2)*	9	9.2

Month	Sunshine				Global Radiation				Precipitation	
	monthly total h		sunless no. of days		monthly total kJ/cm^2		daily total max. J/cm^2		daily total min. J/cm^2		monthly total mm		days with prec. no. of days	
Jan	37	(48)**	12	(12.4)**	6.6	(7.3)***	491	(543)**	39	(48)***	76	(65.9)**	21	(20.4)**
Feb	107	(73)	6	(7.5)	15.8	(13.1)	1033	(963)	211	(102)	52	(49.4)	13	(16.8)
Mar	100	(115)	4	(5.7)	26.2	(25.9)	1353	(1638)	236	(206)	79	(49.2)	20	(16.2)
Apr	137	(164)	3	(3.3)	38.1	(41.6)	2181	(2252)	341	(335)	120	(44.6)	22	(14.5)
May	103	(226)	6	(1.5)	38.6	(56.9)	2291	(2688)	300	(506)	104	(42.5)	26	(13.5)
Jun	252	(224)	1	(1.6)	66.2	(58.2)	3022	(2812)	427	(517)	33	(55.2)	8	(12.0)
Jul	253	(207)	0	(1.0)	63.5	(56.1)	2706	(2718)	1161	(541)	18	(70.2)	8	(14.2)
Aug	232	(206)	0	(1.2)	51.6	(47.9)	2348	(2298)	509	(437)	27	(86.6)	7	(15.9)
Sep	127	(153)	1	(1.7)	28.4	(32.5)	1680	(1775)	198	(284)	175	(75.4)	20	(14.2)
Oct	107	(104)	1	(5.1)	19.7	(18.9)	1106	(1178)	235	(121)	65	(76.5)	20	(17.7)
Nov	75	(55)	6	(9.6)	9.8	(8.5)	602	(696)	59	(62)	86	(84.4)	16	(20.5)
Dec	68	(42)	10	(13.1)	6.6	(5.5)	407	(384)	35	(38)	61	(74.2)	19	(21.1)

* numbers between brackets: 30 years' average (1951 - 1980)

** numbers between brackets: 13 years' average (1970 - 1982)

*** numbers between brackets: 12 years' average (1971 - 1982)


Motorways
Other main roads
Railroads
Scheveningen
THE HAGUE
VOORBURG
Amsterdam
Utrecht
RIJSWIJK
Naaldwijk
Ypenburg
Loosduinen
NORTH SEA
Monster
Poeldijk
Wateringen
DELFT
Delfgauw
Pijnacker
Kwintshaul
Honselersdijk
's-Gravenzande
Naaldwijk
Schipluiden
De Lier
Hook of Holland
Westerlee
Maasdijk
Maasland
Europoort
MAASSLUIS
VLAARDINGEN
ROTTERDAM
SCHIEDAM
Rozenburg


TOWN CENTRE
THE HAGUE
RIJSWIJK
KRUISLOOKWEG
RESEARCH STATION
NAALDWIJK
ROTTERDAM
Sport grounds