

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD  
AGRICULTURAL DEVELOPMENT AND ADVISORY SERVICE

REPORT ON THE ISHS SYMPOSIUM ON  
POT AND BEDDING PLANT PRODUCTION AT  
MICHIGAN STATE UNIVERSITY AND  
PLUG PRODUCTION IN USA  
APRIL/MAY 1989

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## 1. OBJECTIVES

- 1.1. To attend ISHS Symposium on Pot and Bedding Plant Production and present two papers on module production.
- 1.1.2 To broaden the contacts with specialist growers, and advisers in the United States who would be present at the Conference.
- 1.1.3 To visit some of the best and largest producers of modules in the United States to obtain the most up to date information which could appropriate to the U.K market.

## 2. SUMMARY

- 2.1 Symposium covered breeding, environmental research, growth regulation, irrigation, nutrition, post-production handling and mechanisation.
- 2.2 New plug trays being developed which sacrifice plant density for quality. 80% of the United States is down to plugs. The smallest plugs used are the 800 plug unit, followed by the 600 plug unit which it was considered would be used for Robotic transplanting. The largest plug used was the 150 cell unit.
- 2.3 Extension service run from University very closely in contact with county agents who in general were previously with the Universities.
- 2.4 A computer network system, information transfer system, for access by growers has been developed called Spartan.
- 2.5 Western Flower Thrips a problem in many nurseries controlled by chemicals but very few sticky traps used.
- 2.6 University research facilities are very extensive and very modern. Research being carried out at the Universities was mainly sponsored by Industry.
- 2.7 Computer control of environment was normal in most glasshouse units.
- 2.8 Very little traditional glass however some modern units were aluminium glasshouse structures clad with polycarbonate or double polythene panels though double plastic was mainly used. Units visited in general were larger than those in the U.K. There are 350 Growers only of Bedding plants in the Michigan State.
- 2.9 Roller bench transport systems used extensively all with mesh tops not solid.
- 2.10 Seeding machines were the norm more than one per nursery. Old Mill seeding machine was recommended as a research tool.
- 2.11 Germination room developed with light outside.
- 2.12 "Commercial" humidity sensors not controlling well, more sophisticated equipment is required but price needs to be reduced.
- 2.13 Plant material worthy of consideration in the U.K for pot crops Vinca, New Guinea Impatiens "Tango" and Impatiens Elfin Scarlet.
- 2.14 New race of seed raised Geraniums developed having the habits of cutting raised plants.
- 2.15 Antirrhinum cut flowers market buoyant in the United States breeding is in progress.

- 2.16 Marketing strategies were important due to the distances and time involved, when produce is in the lorries or in air transport. New marketing systems are being developed ie. cardboard pallets, collapsible racks.
- 2.17 Computerised scheduling marketing and invoicing the norm on large units, bar coding being brought in this season for bedding. Produce sold through brokers growers grow. Co-operatives in areas of glasshouse concentration such as Kalamazoo.
- 2.18 Soil mixes were 80% of peat, 10% vermiculite and 10% calcined clay.
- 2.19 Lighting for Geraniums was 50 microls at crop level.
- 2.20 Growth regulants usage was minimal growth control mainly by watering.
- 2.21 Germination technique in situ on benches with artificially created microclimates.
- 2.22 Temperature can be used to control growth (DIF).
- 2.23 Hostas Gypsophylla and Bergenia are all being produced by tissue culture in large quantities to combat disease problems.
- 2.24 Problems with Thevalopisis had occurred where damage to root hairs occurred under stress.

#### **Exchange rate**

For conversion purposes the exchange rate at the time of the visit was \$1.69 to £1 sterling.

### 3. ITINERARY

26 April Flight Gatwick to Chicago

Pan American Seeds, West Chicago, Illinois.

Ball Seed Company, West Chicago, Illinois.

Research Laboratories, Michigan State University

C Raker & Sons, Inc., 10371 Rainey Road, Litchfield

Wenke Greenhouses, 6460 Ormada, Kalamazoo

B & C Greenhouses, 8778 East "H" Avenue, Kalamazoo

Tunier & Sons Greenhouse, 5895 East "L" Avenue, Kalamazoo

Klooster Greenhouse Inc., 7325 East "ML" Avenue, Kalamazoo

Kalamazoo Valley Plant Growers Co-Op, 1144 River St,  
Kalamazoo

Walter's Gardens Inc., 1992 96th Avenue, Zeeland

Glass Corner Greenhouses, Inc., 3525 Bristol NW, Grand  
Rapids

Fruit Basket Flowerland, 3801 Alpine Avenue, Comstock Park

Symposium, Michigan State University

Natural Beauty Plants Inc., Keene Road, Apopka, Florida

8 May Flight Orlando to Gatwick

#### 4. TECHNICAL NARRATIVE

##### 4.1. PanAmerican Seeds, West Chicago, Illinois

All of their plug production was undertaken in 406 plug trays using a peat vermiculite low fertilizer sowing media. It was estimated that 80% of plant material in the United States was grown in plugs.

4.1.1 The seeding machine being used was an Old Mill vacuum seeder able to single seed a wide range of seed types including Begonia and Exacum but it could not seed Marigold. The research capability of the seeder was approximately 11 flats per hour, dependent on seed type and container size. As a research tool it was considered extremely good and better than most of the other seeders in production.

4.1.2 The germinating facility was custom built using 5 seconds of fog per minute. Air was recirculated through a plenum sucking from the base to air space above and then recirculating through the base (Fig.1). The florescent light tubes were arranged 1 at each layer of a 11 tray unit. These lights were situated outside the plenum wall and were giving sufficient diffused light to the crop within but without the disadvantage of heat production. There was a temperature differential between top and bottom of 2°F, but within the germination area the temperature was almost constant. There was one air circulation per minute. The operating temperature of the unit was 70/80°F and the majority of seedlings were only in the unit 3 days. A previous germination unit with lights within had taken Petunias 7 days to germinate to pricking out stage, whilst in this unit they would go through in 3 days. The fogging was applied with a low pressure sprayer giving 50% air pressure and 40% water pressure. The water used was well water 52°F heated up to 80°F. The unit was running on deionised water as clogging of nozzles had been caused by calcium deposits. Temperature control was available within the units and one unit had refrigeration where the temperature could be pulled down for low temperature germination of Primulas. The flats were watered before sowing and then placed in, and not watered until germination was complete.

Humidity control was plus or minus 2% up to 80% relative humidity, after this humidity could not be controlled accurately enough. A New York company produced a humidity sensor similar to the sophisticated ones being used in this country for more accurate control but each sensor cost \$1000.

4.1.3 Copies of the United States trial varieties are held by the author.

4.1.4 New Petunias have been bred called Peppermint Daddy with very good field performance. Strawberry Daddy was more suitable for pot work as it was prone to botrytis in the field. The Daddy mixture now includes new Blue Daddy which next year will be available as a single colour. Breeding was concentrated on large flowers on compact plants, and weather proofing. Super Cascades suitable for

container grown plants, but Super Magics for pack work being very weather resistant. New Petunia available for 1990 was Super Cascade Salmon. Other Petunias were Mirage series suitable for containers and baskets and sheltered positions. Flame Carpet was an extremely good red Petunia with very good weather resistance. New Mirage White was earlier with good weather resistance, and much earlier than Celebrity.

- 4.1.5 Improved forms of Vinca with better overlapping of petals had been bred. Peppermint Cooler appeared to be a very good variety and especially for a pot crop. It was very drought tolerant, high germination of 80%. It is doubtful whether Vincas would be a U.K crop as they need to be grown at 16 - 18°C. A breeding programme would most probably be started for varieties suitable for U.K market. New for 1990 was Pretty in Pink and Parasol.
- 4.1.6 The Alyssum variety bred at Ball Research (U.K) Easter Bonnet is a genetic mix of white, pink and lavenders. Seed price may be considerably higher than the standard Alyssum seed but uniformity and colour range is much improved.
- 4.1.7 The first F1 hybrid New Guinea Impatiens named Tango, has a shorter internode length makes an excellent garden plant in the States, but may be better as a pot subject in the U.K. Should be treated with 2 - 5 ppm of paclobutrazol (bonzi) for a pot subject.
- 4.1.8 The Clown mixture Torenia was an excellent subject for pot and basket work.
- 4.1.9 Pink Splash Select Hypoestes had been developed with more pink in the leaves, and was a very suitable pot variety.
- 4.1.10 In the new range of Impatiens Super Elfins new for 1990 was Super Elfin Coral. All of the Impatiens varieties had been sown 9 days apart to demonstrate early and late pack sowings. The breeding programme was looking for an intermediate flower size good flower cover, plant shape, uniformity of height, and large flower numbers. Elfin Lipstick was a good performer outside, as was Pink Rose and Coral. Salmon Blush was much later than the rest. Salmon Blush is available this year. Coral and Salmon Elfins were extremely good for outside cool conditions, and should suit the U.K market. It takes approximately 5 years for a new variety to be developed. The Scarlet varieties would make excellent pot subjects.

Mixtures - Super Elfin were the most uniform. Super Elfin is a pure white, whereas the rest have cream in them. Lipstick Super Elfin had some colour variation when grown under glass. Coral and Salmon Elfins had been dropped from the mixtures and a renamed Coral had been brought in to match the colour range of the Accents. The Orange and the Red varieties have Bronze bred into their leaves to give a darker foliage to give more vibrance to the flowers. This was essential for the U.K market, as foliage lightens under cool conditions. The major problem with the pack uniformity is Satelliting. This is odd plants growing and flowering above the rest.



- 4.1.11 The standard Coleus is the Wizard series, a new one had been developed numbered 1620, extremely good for baskets, and bred for its compact branching habit.
- 4.1.12 Being bred by Denholm Seeds the Boy series Marigolds were being replaced by the Bonanza series.
- 4.1.13 The Antirrhinum breeding programme was examining the suitability of the different groups for different flowering seasons, and whether these seasons could be extended. Breeding was for length and extension of flower spike. Also for marketing as twisting can occur in transport. Normally they are packed flat and crooked flowers occur after long distance transportation, the normal in the United States. It was not expected to be a problem in the U.K where travel distances would not be longer than about 3 to 4 hours prior to the plants being unpacked and put on market stands. Wet packs had been used in the local area and appeared to give an excellent product. The market in the United States and France could not be satisfied, but there was market resistance in the U.K.
- 4.2. Western flower thrips was being controlled successfully using yellow sticky traps to monitor, and the materials Lanate, Avid, Maverick, Telstar, Dursban, Orthine and Thiodan, some in combinations.
- 4.2.1 Oxygen - the experiments gave two changes of atmosphere per hour. Less than 3% oxygen gave nil germination, from 7-10% gave a drop in germination, and at 10%+ there was a significant increase in germination up to 20%. The optimum treatment 20% oxygen for 7 days gave a better germination and expansion of the radicle. It was considered oxygen in the compost could not be overdone, and the more the better the germination would become, though above 20% this had not been quantified. The germination mean time increased with the decrease of oxygen. Seed grown in media and buried could have an oxygen content reduced to below the 7% level. It had been found there was an inner mucilage layer in Impatiens which could cause problems with germination. There has also been indications that wetting agents affected seed germination.

4.3. Ball Seed Company - West Chicago, Illinois

The Ball Group consists of: George J Ball Incorporated is the major Company, this is then split into three Groups, a Grower Group, a Flower/Seed Group and a Vegetable Group. Under the Grower Group is Ball Seed Company and Ball Seed Superior, in Canada. The Flower Seed Company includes PanAmerican Seed, W. Chicago, Denholm Seeds, California, Ball (U.K.), and Lindervista, Costa Rica. This Department is responsible for breeding. The Vegetable Group consists of Peto Seeds. Ball Seed Company are suppliers for the States both of plant material, seeds, and hardware.

- 4.3.1 The "heart" of the operation was a very sophisticated computerised system. It had the ability of stock control of both plant and seed products, and the ability to order and deduct from stock immediately, and invoice, and arrange transportation. All the accounts prior to the seed orders or plant orders being placed were checked for credit worthiness, and outstanding orders. This

information was passed to the seed and plants departments, where "pick" orders were made up, and transported as and when the grower required them. The system was linked to two mainframe computers by IBM desk tops at every position in every department. The total number of people employed by Ball Seed on this unit was 400 people.

- 4.3.2 Roger Styer and Shawn Laff are responsible for the plug research and seed research for Ball Seed.

Training of staff for Ball Seed was given priority treatment and was undertaken by Ken Johnson.

- 4.3.3 Dr Anne Whealy was responsible for the Plant Research Department whilst Mike Klopmeier was the Pathologist responsible for Stock Certification especially New Guineas Impatiens. Environmental control was discussed with Brian Welz the Greenhouse Superintendent.

- 4.3.4 The Research Unit consisted of a single glass house with two heating zones. There was no ventilation in the two compartments but was ventilated by fans which drew air from a corridor through a padfilter (Fig.2). The corridor was fully thrip screened both on the sides and on the ventilators. In the unit were mobile display units which could be taken out for customers examination of different variety trials. The unit was filled with a sales trial for staff training on varieties and Growers problems. All trials were evaluated at a Sales Conference annually. Environmental control was with a zone optimiser from QTom by Toshiba. All parameters could be controlled - humidity, CO<sup>2</sup>, ventilation, heating, and watering, and was capable of serving up to ten zones. The cost was \$3-5000. The under bench heating was through very small bore pipes which carried water at 150/180°F.

- 4.3.5 A new Poinsetia series Marjos and Noel has been introduced with darker foliage. Also a very dark stemmed and leaved variety called Regal Velvet. The later only produced single stemmed plants. Some work was in progress with Cytokinins to produce basal branching.

- 4.3.6 Rhodociton was being trialled with five plants in a basket. All basket trials were field trialled in full shade and half shade.

- 4.3.7 Western flower thrip control was being undertaken with a regular spray programme using a wide range of materials not approved in the U.K., Avid, Maverick, Dursban, Telestar, Orthine and Thiodan.

- 4.3.8 A large range of New Guinea Impatiens varieties were trialled, some new ones being introduced - the Celebration series - next year by Ball Seed. These are very free branching without pinching. Production from a rooted cutting to a pot plant in 8 weeks at an equivalent cost for heat and production to a 4" Geranium was achieved.

- 4.3.9 Colour breaking is becoming a great problem in cutting raised Geraniums, therefore new seed varieties are being looked for.

- 4.3.10 Some tissue culture Gerbera from Weyerhaeuser appeared no better than some of the past materials.
- 4.3.11 A new plant from seed similar to an Hibiscus called an Abamoscos had been developed which made a good pot plant from a February transplant.
- 4.3.12 In the Seed Department over 2000 varieties of seed were kept. The genesis type seed, the high energy seed, the tailed seed, and the graphite coated seed. Speed seed and pelleted seed were also kept. Any seed in sealed packets and remaining after 6 months in store was retested for germination. Seed was counted either by weight or by electronic counters with an Old Mill counting machine. Temperature in the store was 70°F with humidity at 30%.

4.4. Michigan State University, Horticultural Facility - West Lansing

Environmental control in the Research Unit was with Oglevee, Vitrotech, and Priva computers. Both the Oglevee and the Priva systems had a 2°F accuracy of temperature control. The Vitrotech system was a distributed system, and gave much better control, it was capable of recording 80 variables, and storage of data up to 30 days on hard disc. This could be dumped daily on to soft disc and was updated every day, thus leaving behind only 30 days of data. The Vitrotech system was operated by means of a light pencil on screen to change set points etc.. Graphing could be either 24 hour or a 1 hour. There was only one sensor in each compartment which were only 10 x 30 feet. The temperature graduation in the houses was 1°F with the Vitrotech equipment, based on plant temperature measured by infra red temperature sensors.

- 4.4.1 Differences of day and night temperatures can affect plant height. Cool days and warm nights produced shorter plants. A 25°F day/night temperature continuous combined with two photo periods on seven species was being carried out. The light quality was being examined ie. far red, and red, against no light at all. An experiment also examined the possibility of light flashes at night and the effect on plant quality. It was thought continuous light could eliminate night temperature effects. Plant height could also be controlled by low temperature for the first 2 hours of daylight. This had been achieved by dropping the temperature to half of the night temperature at first light ie. If the night temperature was 18°C dropping down to 9°C at first light for 2 hours.
- 4.4.2 An experiment examining germination and bud abortion in seed raised Gerbera had been sponsored by Sakata. Plants had been watered by light measurement, and they were watered at every 5 mols of light on an accumulative basis.
- 4.4.3 Light quality influenced the number of flowers per node on Fuchsias, the better the light quality the more flowers per node. Sub-irrigation equipment applied 200 ppm N and K. There was little difference in crop performance using either sub-irrigation

or watering over the top, in the comparison of water amounts used for growth control on Marigolds, Impatiens and Geraniums. Controlled release fertilizers had been used on these crops and providing they were watered without leaching they had satisfactory nutrients to carry them to the end of the crop. Petunias however needed some feed towards the end of the crop. Four feed treatments x high light and low light treatments had given dramatic effects on the use of fertilizers with these crops but was not analysed. The Geranium crop had shown problems with low pH's below 5. An experiment was looking at lime treatments and the effect of the pH on water quality.

4.4.4 Vernalization of hybrid lillies was being examined and their response to temperatures using 11 different regimes, and the light and temperature influence on flowering.

4.4.5 The suite of growth chambers gave the ability to examine plant growth very minutely. 50,000 different measurements could be taken by computer using an angular displacement transducer which was fed into a computer on hard disc. All the growth points could be completely isolated second by second and from this information crop models had been evolved. Two were already written, one for the Chrysanthemum crop, and one for the Geranium crop, from the quantitative measurements which were obtained from the growth cabinets.

4.4.6 The Spartan Ornamental Network had been built up by Dr. Will Carson of the Extension service. It gave the information via computer to subscribers on Tips of the week, Data bases of 30 bedding plants, and 25/30 pot plants, Availability of work in the area, current pest and disease recommendations, current fertilizer maps, Growth Regulant maps, and Horticultural lighting programme. The programmes had been in existence for eight years. The programmes operated on a Menu and data base. In approximately 3 months both are to be changed and have a search capacity. Sixteen people could access the system at one time. The cost to the grower in the Michigan area was \$150 a year plus phone calls at standard rate. Out of State the current cost to growers was \$250. The system could be accessed from anywhere in the world. The major problem remained information input into the network. Within 6 months all of the publications produced by Michigan State University were to be put on the network, cutting up to 6 months to a year from publication time.

#### 4.5. Kalamazoo River Valley - Michigan

This area originally was one of the major celery producing areas on organic soil, and was settled by Dutch imigrants. As the celery became less profitable greenhouse production took over, using the small propagation units that were originally used for the celery. As the demand increased for Bedding these units changed to Bedding Plant production and became the large units they are today. The area has a Grower's Co-operative with 41 members, which schedules production and markets all over the States to Garden Centres and other producers. Pot Plants are limited in the area, the main crops being Bedding Plants and Hanging Baskets. There were problems concerning nitrates and

these were being addressed in the near future.

The normal production schedule of a unit in the Kalamazoo area is 1.6 crops per annum, plus a full crop of Poinsettias in the Autumn.

#### 4.6. Rakers Greenhouses - Litchfield

This 120,000 square foot unit was computer controlled, with shade screens. It had a mesh topped roller-bench transport system with under bench heating of gilled pipes. There were light units in all houses, and the structures were Polycarbonate curved profile houses with roof ventilation.

- 4.6.1 The plug production was 15 million ornamentals, and 15 million vegetables, per annum. The main vegetable crops were Sweet Pepper and Tomatoes and such as Water Melons. It was the largest and most advanced plug unit in the USA.
- 4.6.2 A new type of seeder was being developed with Blackmores with easy change multiple seeding heads. The seeder, a rotary drum type, was capable of seeding 600/700 trays per hour using custom coated seed. Seed was transferred from one roller to another, accuracy for Tomatoes and various other fairly large seed subjects was 99% singles. Standard Blackmore and Old Mill seeders were used for the main operation.
- 4.6.3 A monorail system was used for transporting plants within the house. The thermal screen was an aluminum strip type. Lighting was used for Geraniums mainly from December through to February. Lighting from dusk to 12 to 1 o'clock in the morning, giving 6 hours supplementary light for a maximum 18 hour day. The light level was 50 micromols at crop level.
- 4.6.4 Cycocel was used on Geraniums at 1800 ppm, and B9 on Petunias at 3,000 ppm. Only about 5% of the crop was treated with any growth regulant, the main growth regulant being used was water control.
- 4.6.5 The cell size being used on this unit was 128 cell unit, 16 by 8 rows, but impatiens were in modules with 32 by 14 rows. Many cells were empty eg. 406 unit of Impatiens was sold as a 350 plant unit and seldom was there any necessity to gap up. Many marigolds were twin seeded.
- 4.6.6 Insecticides and fungicides were applied through spraylines. The watering was by mobile spray booms and this showed in the uniformity of the crop. The time of application of water by booms was by the most experienced growers and by this means the minimal use of growth regulants was possible whilst still giving even crops.
- 4.6.7 All the produce was sold through Brokers, to their 2,000 customers. All the material was trucked out by Federal Express, and then by air. The standard delivery time by air was two days, however a priority shipping order would get the materials to the grower within 24 hours. The price of plugs delivered to the grower for 392's was 6 cents for ornamentals and 4 cents for vegetables

and for the larger plugs the price was 8 cents and 6 cents respectively these charges include shipping, and brokerage. The company used two computers one for scheduling for production and linked in with the orders and the other for stock control. The scheduling programme contained a sowing and seed requirement for given schedules.

- 4.6.8 Staffing of the unit was the grower, his two brothers, his wife who ran the office, five greenhouse supervisors, three packing staff, and twenty other staff. The income from the unit was \$9 / sq ft and six crops were produced per annum thus \$54 / sq ft /annum.
- 4.6.9 Germination was within the house using a very simple system of a net cover over the plugs once sown then using a mist boom and bottom heat, thus creating a microclimate within the house. The net cover was called Agronet and was machine laid over the modules once sown. The fogging system pressure was 600 psi and was used in the summer for germinating cyclamen at 98% humidity, enabling small compact plants to be produced with little disease and without compost saturation.
- 4.6.10 The salary for a plug grower would be approximately \$18/20,000 per annum which would include bonuses and profit sharing. The younger growers all had horticulture degrees or horticulture training, whilst the older growers were mainly qualified by experience. The young horticultural workers required 4 years experience before they were taken into businesses.

4.7. Wenkes Greenhouses - Kalamazoo

A very large grower retail operation producing mainly Geraniums and baskets. It had been operating for 20 years as a very large Garden Centre. Attached to this was an 80/90% wholesale business. Very little plant material was bought in, their excess production was sold out through the Growers Co-operative in Kalamazoo.

4.8. B and C Greenhouses Incorporated - Kalamazoo

A glacial drift ran through this region in early days with terminal morraines and the greenhouse unit was erected on one of these. They have the only large block of Dutch glass in the area the rest being polycarbonate or plastic. The unit is run by two brothers who are also Brokers for other Bedding Plant Growers in the area. The unit is mainly double polythene, and a total coverage of 5 acres, 1 acre of glass and 4 acres of polythene. All the compost is bought in in prefilled trays. The greenhouses are heated with gas and steam batteries. At present the unit is on 50% plug production, the rest being pricked out. There were standup watering spray points in each house. Staff brought their children along, the only way of keeping regular labour, and babies in prams and baby bouncers were seen in the greenhouses.

4.9. Tuniers Glasshouses - Kalamazoo

This 4 acre unit was run by three brothers. A Hamilton Drum

Seeder capable of sowing 1 flat in 4 seconds was used and was considered more accurate than the standard Hamiltons that had been used previously. Seed was covered with vermiculite to save seed and flats drying out. Remay and white plastic was used for covering some seeds such as Begonia. Their own mix was a peat/vermiculite mix, including some styrofoam. The fertilizers used were 20:10:15 and a 21:20. The lower phosphate fertilizer was used to stop young seedlings stressing in the Spring. The temperatures at night were always kept warmer than day to give growth control. The normal sized flats were a 54 and 72 (Fig.3). Ventilation and heating in the polythene was controlled by Honeywell computerized thermostats. A Priva computer controlled the new aluminum framed greenhouse covered with double polythene and polycarbonate and side ventilation. The cost of this double polythene glasshouse was \$100 per square metre. The gap between the double polythene which had internal 1 metre supports was 1 foot, and the gutter height was 10 feet.

#### 4.10. Kloosters Greenhouse Incorporated - Kalamazoo

The unit had been in growing for 30 years and produced 130,000 flats of ornamentals mainly Geraniums, 12,000 flats of vegetables, and 5/6,000 hanging baskets per annum. There was a transplant and assembly line on the unit, and conversion to plug production was now 100%. Plug production was started 7 years ago by buying a Vandana Seeder. They commented a seeder should be the last thing that a plug grower should buy, he should learn to grow plugs prior to trying to produce with a seeder. An example of the transplant line is at Fig.(4). The compost was peat Heco No.1 a fertilized peat plus polystyrene granules and vermiculite. They also included a granular Banrot for disease control in the compost. The moveable bench systems were skirted. High intensity lighting was used extensively at the same rate as mentioned previously (4.6.3). A new type of multi-blooming Geranium had been developed which should be in the market within a year. All the plants were watered by going through a watering system directed onto market trolleys prior to marketing, this sprayed water from the side in through the 11-layer trays. Of the 70 truckloads which went from the Kloosters unit per annum only 5 would be wholly from one producer.

Instant colour packs for landscape production of plants deliberately grown fairly tall with 18 plants per pack were being produced. A cold section run at 55/60°F produced Allysum, Antirrhinum, and Pansies. The costing for the Westbrook Canadian house was 4\$ per square foot including heating, irrigation, etc. Alar was used as the main growth regulant at 3,000 ppm. Two types of flats were used some with 4 sections in a tray, and some with 3 sections in a tray, those giving a 72 flat unit, and a 54 flat unit.

#### 4.11. Kalamazoo Valley Plant Growers Co-Operative

The Co-Operative shipped 2½ million flats of bedding plants per annum. Twenty five loads a day were transported in the peak of the season. The Co-Operative makes the sales contracts with the grower, plans the production, bulks the orders and collects from

the growers. The grower packs his orders, and the Co-operative by a computer system distributes and invoices the buyers. Trucks leave the Kalamazoo packing station for 35 States from the East Coast to the Rockies. 80% of their sales are in a 3 month period between March, April and May. They sell also bedding Poinsettias and Pot Mums in the Autumn, but this only accounts for 10% of annual sales. All invoicing is from the Kalamazoo office. 41 growers are in the Co-operative and are all suppliers to the Co-operative. They supply 2,000 customers. The growers set the base price then administration costs of 10-11% and transportation costs which can be from nil to 22% depending on the distance travelled are added.

Some new marketing systems were examined which have been developed by the Michigan State University. One consisted of cardboard trays with cardboard supports between and making up an 11 pallet load which was then plastic covered (Fig.5). The cardboard boards were able to withstand 800 lbs weight and on the bottom, and also they were returnable and could be used for 3 years also they were lighter than wood or metal thus reducing transport costs based on weight. They were also examining use of collapsible racks for return, but these were very expensive almost double conventional racks. Normally most units would require 2,000 units thus making the system too expensive.

The requirement of a grower member was that he supplied plants to the Co-operative but did not necessarily all his production, but had a contract never to undercut the Co-Operative price. Half of the growers in the Kalamazoo area were within the Co-operative. The committee had the right to stop sales if the quality of the produce was not good enough. Up to 15 growers could contribute to one load. A weekly inventory was given of the plant material available so that the growers could plan their production further. Baskets were all marketed in boxes with 2 plants per basket and on racks with 6 layers of 32 plants per layer.

A successful Co-operative needed all units to be of the same size and to have a market not accessible to every one of them, otherwise competition would occur. The Co-operative's objective was specialization and monocropping with a centralized packing and marketing area.

#### 4.12. Walters Gardens Incorporated - Zeeland

Started in 1946 with 4 acres, now operating 1,000 acres of perennials outside, and 100,000 square foot of glass. They are the biggest Hosta growers in the world producing one-third of their material by tissue culture. The explant spends up to 3 months in a small speedling plug, prior to planting up in to their final six inch deep container. The turnover was one million dollars from Hostas, and the major line is Hosta undulata, and H'lbo marginata. Their new Hosta introduction was Hosta Northern Lights. Though Hostas can be produced by tip cuttings, root cuttings, and divisions, the bulk of the plant material was produced by tissue culture. Hostas were transplanted from the tissue tubes into speedling trays. Crops were grown on mobile benches covered with Mypex.



- 4.12.1 Tissue culture for Gypsophila was used because of attacks of crown gall had almost stopped production of this crop. Five hundred million Gypsophila plants were produced in plugs and in 2½" pots, which handled well and could be shipped long distances. New varieties of plants seen were Lamiastrum and Chrysanthemum Thomas Killen. Planting of the perennials outside was done mechanically by six machines operated with five people per machine with an output of 40,000 plants per day. The company is one of the largest perennial producers in the States. All of the product was marketed by United Parcel Service in refridgerated transport. The material was held in the winter months in seven cold stores run at 28°F.
- 4.12.2 The tissue culture laboratories have been in existence for the last eight years. All equipment was sterilised in an autoclave. The tissue tips were taken under transverse air flow cabinets. Shoot tip propagation gave the greatest chance of clonal stability. Tissue culture subjects produced were gypsophilla, hosta and bergenia. The production through the unit was approx one million plants per annum 50% of which were hostas. The reasons for using tissue culture were to increase stock which was not freely available, to propagate poor rooting species, to overcome disease problems for example Crown Gall, and for rapid stock multiplication. The monthly throughput was approximately 140,000 to 150,000 plants.
- 4.12.3 The majority of the material was hand and boom watered. Ebb and flood benching was just being installed. The cost of traditional benching was \$2 per sq ft whilst for ebb and flood it was \$4 sq ft Bonzi was used on pansies and impatiens at 16 ppm whilst geraniums were treated at 1/4 ppm. African Marigolds were in full flower and had been blackclothed for 9 hours a day for the first three weeks of production.

#### 4.13. Fruit Basket Flowerland - Comstock Park

The production company had four outlets, three in Grand Rapids and their latest opened in 1987 in Lansing. All were very large Garden Centre outlets selling plants and sundries. The company started in 1948 selling as its name suggests fruit and vegetables then moved into its present trading mode in 1972 when urbanisation developed in the area.

- 4.13.1 The turnover for the four stores is 32 million dollars. 2.1 million comes from the sale of chemicals for pest and disease control, 2.3 million comes from roses trees and shrubs, and 2.8 million from annual bedding. Four percent of their budget is spent on advertising not on TV, but by hard advertising in newsletters and newspapers.
- 4.13.2 The busiest week of the year was one week prior to Mother's Day. Very little is grown on the unit most is bought in from neighbouring growers. All of the signs on the Nursery had been generated by computer (Mackintosh Apple) and were laminated after printing. The two main seasons are April/May and November/December for the Christmas market. They endeavour to

keep as wide a range of products as possible to cater for the connoisseur and the new gardener. All American Selections are available providing they can be obtained at economical prices for retailing on to the public.

4.13.3 The Centres feature Plant Doctor's who are certified nurserymen who put on white coats at the weekend and sit and answer questions in booths from amateur gardeners on pest and disease and diagnose problems. A free landscape service was offered to any customers who cared to draw their garden on a square pad. The employees then produced plans in the evening and were paid \$6 a plan.

#### 4.14. Natural Beauty Plants Inc. Apopka - Florida

The unit consisted of 24 acres under glass, and a 4 acre shade unit. The total production is  $\frac{1}{2}$  billion plugs, 90% sold wholesale.

The unit had only changed to plug production over the last two years previously growing foliage plants. The total weekly production was 50,000 trays. Module sizes used were 392, 288, 220, 112, and 77. The 220 was a new tray, designed by Gene Grieling. The tray had an air space around each cell see diagram (Fig.6). The loss of space in the new tray was more than adequately made up by the increase in quality. Geraniums and Impatiens were grown in the 288 tray. Nicotiana, Petunia and Begonia were grown in the 77 trays and 112 called their Expedito trays.

- 4.14.1 Drum seeders and a Vandana tubeless seeders were used for direct seeding the plug units. The compost mix used was Heco seedling plus calcined clay and vermiculite. The compost mixing line is at diagram (Fig.7). Every batch of plants was colour flagged indicating the finish date once out of the germination chamber. Germination temperatures were 75°F for most subjects.
- 4.14.2 Shading and black cloth screens were available for day-length control. All of the unit was on a mobile transport table system with mesh tops except where Begonias were being grown when styraform table tops were used. Irrigation was automatic by a fog and a boom watering systems. In spite of the computerised shade system the roofs were also sprayed with shade paint.
- 4.14.3 Sprays were made up at central points which were ventilated to the outside. The sprays were then pumped to junction points throughout the unit where only small runs of hose and spray nozzles were necessary from these junction points. Safety was paramount and notices were displayed advising which area had been sprayed and which was safe to enter. This was an indication that safe use of spray chemicals was taken extremely seriously due to EPA in the States.
- 4.14.4 Different soil mixes were used. For foliage 70% Peat, 10% Perlite 10% Vermiculite and 10% Calcined Clay. An 80% Peat, 10% Vermiculite and 10% Calcined Clay was used for bedding plants.
- 4.14.5 The unit produced 90% of the plugs for Ball Seed and the remaining 10% of its production was foliage plants, and colour

bedding. All of the produce was bar coded. Colour bedding was also produced for Disney World in 3½ and 4" pots. A new range of multi-flowered Geraniums from cuttings in a good range of colours called Selecta was being multiplied in Georgia produced from the original stock of Selecta Kleman in Germany.

4.14.6 Some plant material for Natural Beauty was produced in Winsconsin, Georgia as well as in Florida. Poinsettia stock for the Christmas crop had usually been produced in Georgia and the rooted cuttings shipped to Orlando for flowering. It was expected this year the crop would be propagated and grown in Orlando. The Poinsettia crop was usually stuck the last week in June.

4.14.7 It was interesting to note that the accent was on quality all of the time. Any plant material that remained two weeks after the projected market date was thrown away and no attempt was made to market it at a lower grade.

4.14.8 The shade house was clad only on the roof and had completely open sides, the framework was aluminium glasshouse.

4.15. ISHS Symposium on Bedding and Pot Plant Culture - Michigan State University

All papers from the Symposium will be published in Acta Horticulturae in due course and abstracts are held by the author and can be obtained on request.

The first session of the Symposium dealt with Breeding and Propagation.

4.15.1 W.N. van Kester discussed current status of breeding and seed propagation of ornamentals from the European perspective.

Successful varieties were unique and uniform in many respects. Major selection requirements for future varieties were high seed quality, a high level of disease resistances, a predictable cropping schedule, good stress tolerance and adaptation to a wide range of climates and treatments with low inputs of chemicals.

More and more, breeders will have to take into account, as new breeding criteria, the interaction of components with applied technology, eg. breeding material will have to be more adapted to tissue culture application, it will have to respond uniformly to specific seed treatments.

4.15.2 Richard Craig dealt with the same subject at 4.15.1 from the United States perspective.

The age of biotechnology was beginning and its application to flowers would result in a "quantum leap" in knowledge. New cultivars were being designed to increase productivity, quality and diversity of products. Emphasis for future research would include clean stock, host plant resistance to pests and diseases, postharvest quality, efficient nutrition, and stress tolerance. Of critical importance would be the development of cultivars and production systems which would be neutral with respect to their

impact on the environment.

- 4.15.3 Sheila D. Linderman and Lowell C. Ewart in their study of Interspecific Hybridization in Zinnia whilst examining the Morphology, Cytology, Pollen, and Powdery Mildew Resistance had found genes Z.a x Z.e. and Z.a. x Z.h. resistant and Z.e. x Z.a. moderately susceptible to the powdery mildew. This germ plasm could serve as a source of disease resistance and could be incorporated into commercial cultivars through further breeding.
- 4.15.4 R. Rober and K. Kollen discussed the influence of young Plant Material on the further development of Pelargonium Plants. Plants propagated by cuttings of P.z "Vulkan" were to be preferred before those propagated by seeds. Cuttings were more easily propagated. Furthermore flower drop was another disadvantage of many varieties propagated by seeds.
- 4.15.5 Other papers in this session dealt with breeding work and included:
- Pan, S. - Orange flower colour inheritance in Pelargonium x hortorum.
  - Perkins, R. - Genetic male sterility in Petunia.  
(Ewart, L.)
  - Becker, W. - Pollination, seed set and pollen tube growth  
(Ewart, L.) investigations.
  - Robertson, E. - Breeding and genetics: Flower colour inherit-  
(Ewart, L.) ance in Salvia splendens.
  - Cowens, R. - Inheritance of a male sterile apetalous  
(Ewart, L.) inflorescence in Zinnia elegans.
- 4.16. In the session devoted to Environmental Experimentation the main papers were given by Roar Moe on control of plant morphogenesis and flowering by light quality and temperature, and Ludger Hendriks on current status of environmental research on potted and bedding plants in Europe with special emphasis on temperature.
- 4.16.1 Roar Moe discussed control of plant morphogenesis and flowering by light quality and temperature showing elongation of plant stems, flower stalks and leaf petioles, lateral branching, shoot and leaf orientation and leaf pigmentation are influenced by both light quality and temperature. The relationship between DT and NT (DT minus NT = DIF) strongly influenced internode length and plant height in a wide range of pot and bedding plants. Whilst average daily temperature only slightly influenced internode length. Plants grown with a positive DIF (DT NT) were taller at maturity than plants grown with a negative DIF (DT NT). Leaf unfolding rate and flower development were not affected by DIF, but by average daily temperature.
- 4.16.2 Ludger Hendriks paper discussed the development of heating and production strategies for regulating the greenhouse environment with climatic computers, and the growing awareness of environmental protection in many countries. This has led to research on how to reduce raw materials in short supply like peat, water and energy and how to protect soil, air or groundwater from pollutants.

4.16.3 These two papers were supported by Poster presentations:

- Vogelezang, J. - Effect of bench heating on crop responses, as influenced by CO<sub>2</sub>, temperature, and light.
- Vogelezang, J. - Supplementary lighting for pot plant culture.
- Dansereau, B. - Influence of light intensity and photoperiod on the growth and development of Gerbera.
- Roberts, G. - Photoperiodic response of *Sisyrinchium bermudiana* - a possible new bedding plant.
- Karlsson, M. - Temperature controlled leaf unfolding rate in Hibiscus.
- Graper, D. - Supplemental irradiance control of *Petunia* seedling growth at specific stages of development.
- Kessler, A. - Effect of supplemental light and duration of exposure on growth and flowering of *Begonia semperflorens*.
- Hoyer, L. - Developmental stage of *Capiscum annum* 'Janne' determine the critical ethylene exposure.
- Lee, W. - Evaluation of temperature effects on the growth and flowering in different cultivars of *impatiens* (*Impatiens walleriana*).
- Lange, N. - Modelling flower induction in *Lilium longiflorum* by temperature and photoperiod.
- Erwin, J. - Thermomorphogenic responses of *Schlumbergera truncata* flower initiation.
- Berghage, R. - The relationship between day and night temperature influences photosynthesis but not light compensation point or flower longevity of Easter lily, *Lilium longiflorum* Thunb.

4.17. The second Environmental session was led by Rolf Larsen, discussing plant growth modelling by temperature and light, and Jim Barrett presenting the current usage of growth regulators on bedding and pot plants.

4.17.1 Rolf Larsen described the concept of mechanistic crop modelling and explained simple numeric integration of dynamic models. Special emphasis was given to flower development, growth of plant diameter and stem elongation.

4.17.2 Jim Barrett and Terril Nell discussed current usage of growth regulators on bedding and pot plants.

Some of the current changes were due to concerns over environmental pollution caused by use of agricultural chemicals. Other changes are because researchers are beginning to study growth regulators as part of a total production system and not just as an isolated factor.

The interaction of fertilizer rate, water stress, and growth regulant rate on growth of *Petunia* and *Impatiens* was discussed. Temperature effects on *Poinsettia* and response to chemical treatment, variability in the efficacy of Paclobutrazol and Uniconazole for different species, and the importance of application procedures for different chemicals were also discussed.

lead time is already short for averting disruptive effects of such regulations on commercial production. Contribution of nitrates to drinking water supplies, phosphates to surface waters where eutrophication would be induced, or salts in general to any water supplies would be targeted.

The paper discussed methods of fertilizer application and the economies of water and nutrient application.

4.18.3 Other related papers in this session were:

- McAvoy, R. - Poinsettia growth in media containing XE-1019 impregnated Rockwool.
- de Graaf. - Watering strategies in bedding plant culture: Effect on plant growth and keeping quality.
- Jacques, D. - Identification of Ca movement in Poinsettias using autoradiography.
- Farthing, J. - Effect of pH and phosphate on germination and emergence.
- Takano, T. - Effect of a mixture of organic substances and iron on the growth of Chrysanthemum and Rose.
- George, R. - Potential for transfer of Pythium ultimum in production of seedling Geraniums with subirrigation and recirculated solutions.
- Yelanich, M. - Effect of fertilizer concentration and method of application on media nutrient content, nitrogen runoff and growth of Euphorbia Pulcherrima, V-14.

4.19. The final session was devoted to Post Harvest and Mechanization. John Hoogenboom discussed Mechanization and materials handling from the commercial standpoint, and Terril Nell described work on Post Harvest handling of bedding and pot plants.

4.19.1 John Hoogenboom stated the market in the States was for multi-purpose equipment. One of the major problems being service as there were no dense concentrations of glass as in Europe. He described a new complete automated closed transport system. The system was for Single Crops of runs up to 400'. The minimum size of the units must be 2 acres to be cost effective. With the collection of run off water being enforced before long by EPA it was likely closed systems would be statutory.

4.19.2 Terril A. Nell presented a paper on the post production handling of bedding and pot plants.

Results from these studies demonstrated proper production practices, shipping conditions and interior handling procedures were necessary to maximize the longevity of foliage and flowering pot plants. Likewise, garden centre display conditions which expose bedding plants to undue stress, limits the performance of these plants in the landscape garden. For instance, low production light levels must be used to successfully acclimatize foliage plants to interior environments, though, conversely low production light level reduced the longevity of pot Chrysanthemums.

4.17.3 The following Posters supported the main speakers:

- Wang, X. - Growth response of 'Connecticut King' lillies to Sumagic and GA 4+7.
- Wang, X. - Effect of Cycocel and Sumagic on growth of three bedding plants.
- Zhang, X. - Year-round scheduling of seven dwarf asiatic hybrid lily cultivars.
- Anderson, R. - Effect of growth retardants on satin flower Godetia, for flowering pot plant production.
- Holcomb, E. - Height control of selected bedding plants with Uniconazole.
- Karlsson, M. - Evaluation of low temperature flower initiation in Chrysanthemum using several microscopy techniques.
- Farthing, J. - Growth regulants for modules.
- Graper, D. - Synergistic acceleration of Begonia semperflorens development using supplemental irradiance and soil heating.
- Armitage, A. - The influence of light intensity, photoperiod and growth regulators on Pentas lanceolata.
- Berghage, R. - Quantifying leaf unfolding in the Poinsettia.
- Erwin, J. - Thermomorphogenic and photoperiodic responses of Nephrolepis exaltata 'Dallas Jewel'.
- Jiao, J. - Whole plant net photosynthesis of miniature roses as influenced by CO<sub>2</sub>, temperature and light.

4.18. In the session on Irrigation, Nutrition and Growth Media Heinz-Dieter Molitor's paper examined the European perspective with an emphasis on subirrigation and recirculation of water and nutrients. Whilst Paul Nelson looked at the United States perspective with emphasis on surface applied, non-recirculated systems.

4.18.1 Heinz-Dieter Molitor discussing the European perspective with emphasis on subirrigation and recirculation of water and nutrients said the pollution of well water with nitrate and residues of pesticides had already led to first regulations by the European Community and, first of all, by the government of West-Germany. Closed cultivation systems, preventing the loss of water and nutrients, should help the greenhouse industry to accomplish government restrictions.

Depending on the cultivation system, different types of closed systems must be taken in consideration. For pot plant production, sub-irrigation solves the problem. Stock plants should be cultivated in hydroponic systems such as rockwool, with nutrient solution recycling, or in NFT.

4.18.2 Paul V. Nelson discussed the United States perspective with emphasis on surface applied non-recirculated systems.

There are several strong impetuses for managing water and nutrients in greenhouses. Establishment and regulation of nutrient efflux limits were imminent in America and Europe. The

4.19.3 Other papers in this session were:

- Anderson, R. - Use of pot plant mechanization techniques to produce short stemmed cut flowers for supermarket bouquets.
- van Lieburg, M. - Prevention of phytochrome-induced post-harvest loss of quality in ornamentals through light emitted by diodes.
- Armitage, A. Outdoor evaluation of bedding plants - An in-depth approach.
- Olson, K. The influence of irradiance on ethylene sensitivity and post-production quality of *Pelargonium x domesticum*.



# GERMINATION CHAMBER

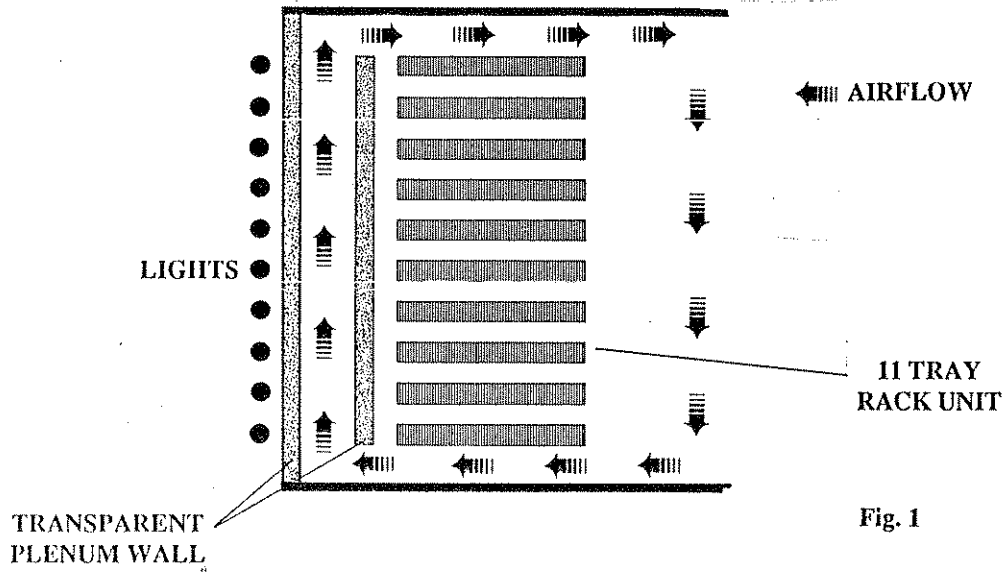


Fig. 1

# THRIP PROOF GREENHOUSE

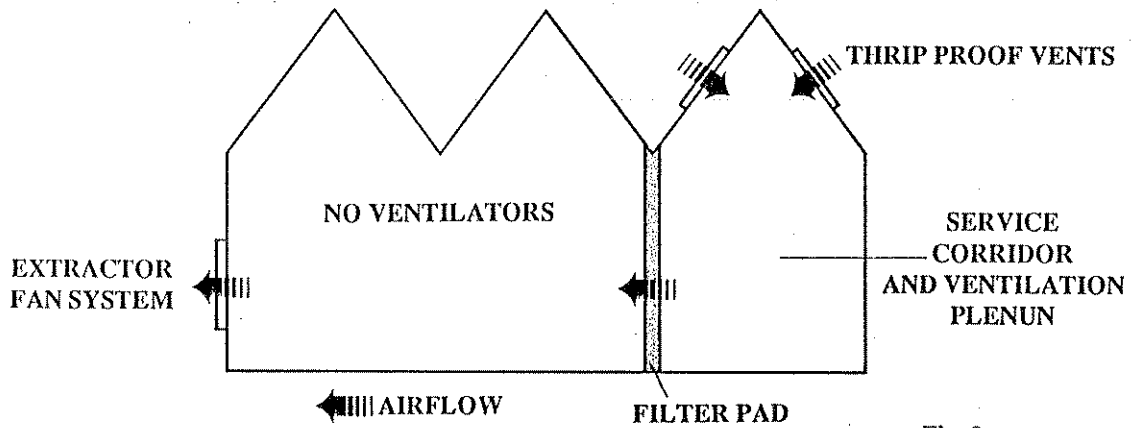


Fig. 2

# FLAT TYPES (54 or 72 plants in flat)

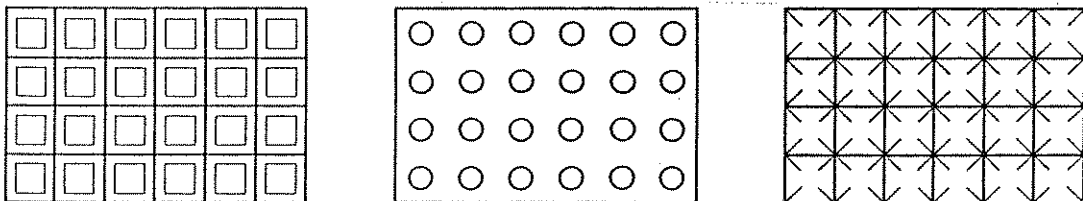


Fig. 3

## TRANSPLANT LINE



Fig. 4

## CARDBOARD PALLET SYSTEM

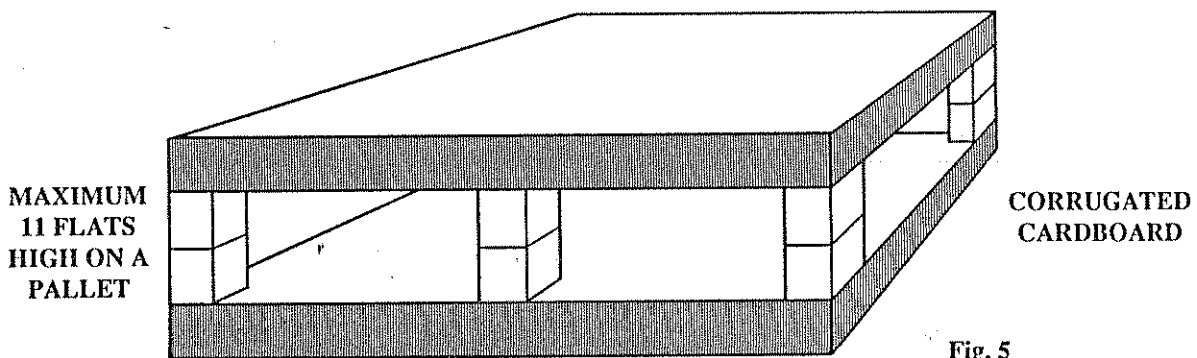


Fig. 5

## NEW CELL DESIGN

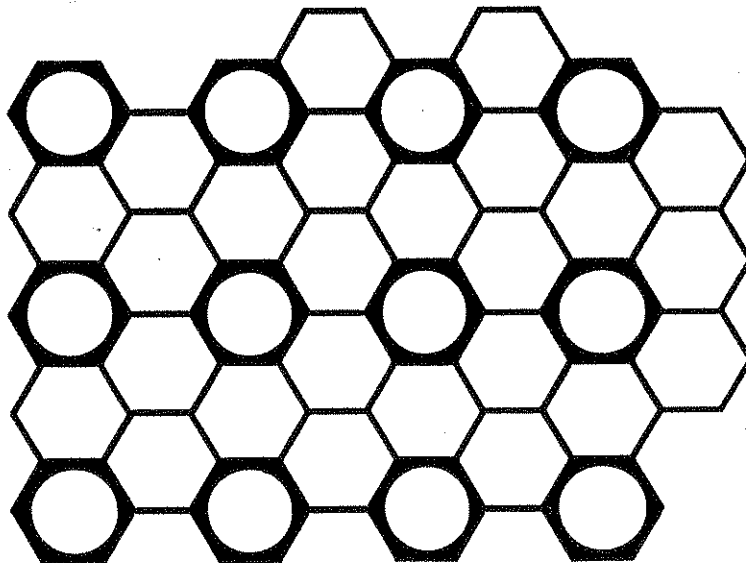


Fig. 6

# SOIL MIXING LINE

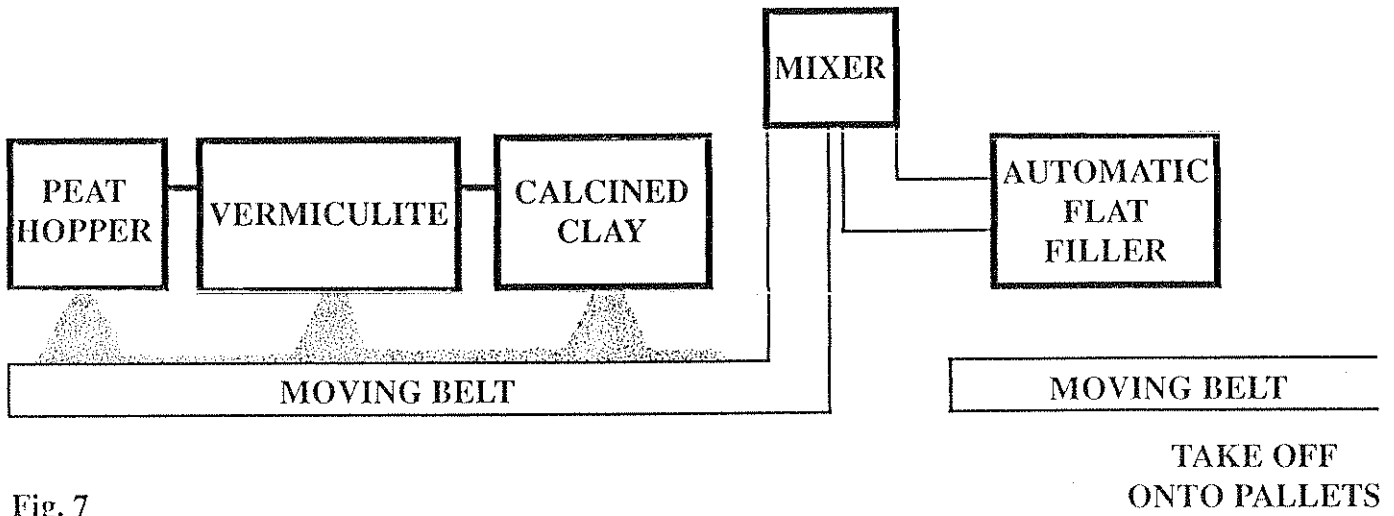


Fig. 7

6. **ACKNOWLEDGEMENTS**

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