Final report (May 1997)

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RELEVANCE TO GROWERS AND COMMERCIAL APPLICATION

1.1 APPLICATION

The bedding plant industry has an estimated output of between £160M (MAFF) and £450M (growers estimates) per annum. As such it comprises a considerable proportion of the output of the UK protected crops sector. However, the industry is still relatively young having shown dramatic growth over the last 10 to 15 years. Despite this rapid growth, there has been relatively little research and development conducted to enhance crop production and economic returns for bedding plant growers. To the extent that even the responses of bedding plants to temperature and light, two of the primary environmental variables, are poorly understood. This lack of understanding of bedding plants responses to environment places great limitations on growers. They do not have information on how to schedule crops accurately or the optimum temperatures that maximise profits and plant quality. Poor scheduling and the resulting plant wastage is thought to lead to annual losses of up to 10% of total UK production; i.e. between £16M to £45M per annum to the industry as a whole.

In order to help alleviate this deficiency two HDC projects have been conducted recently at the University of Reading (Pearson *et al.*, 1995 and 1996). The aim of these projects was to increase our understanding of the responses of bedding plants to temperature, photoperiod and light integral, and to develop mathematical models that can be used to schedule crops and forecast maturity dates. As a result of this work sowing date schedules have now been developed for 7 of the main bedding species; antirrhinum, geranium, impatiens, marigold, petunia, pansy and salvia.

The development of these models also allows an opportunity to determine the most economic growing regime to produce the crops. For example, as the models predict the effects of temperature on time to flowering, they can be used to determine whether it is more profitable to grow the crop fast at high temperatures, or at lower temperatures which save on fuel. A whole range of other production scenario's can also be tested. This project aims to address these issues by using the models to predict the economic effects of environment on time to flowering, in conjunction with an existing software package designed for the financial planning of bedding and pot plant production (GARTPLAN).

1.2 AIMS

The objectives of this proposed study are :

"i. to provide clear easily understood technical and economic guidance for growers, to enable them to make full use of the production schedules developed at The University of Reading

ii. to help them maximise their returns through the use of these schedules."

1.3 TERMS OF REFERENCE

To fulfil these objectives sowing date schedules were determined using the models

described by Pearson *et al.*, (1996), for each of the seven species stated above, and for plants grown at one of three different set point temperatures, typically 14, 18 and 22C. These schedules determined days to maturity from sowing dates typically between January and May.

A survey of growers of varying sizes was also conducted to establish key facets of their production systems. These included the scale of production, the size of the pots and packs to be used, the methods of production (eg bought-in or home grown plugs), the spacing regimes to be followed and typical physical / labour data used for the main production operations etc. Financial data was also gathered, including typical variable costs for each type of production and crop, typical overhead costs from the selected small, medium and large scale growers and typical sale prices for the different crops.

The data from the schedules and the survey was then input into the financial planning program "GARTPLAN". This was then used to determine the profitability of a range of growing systems for each of the seven species; including the effect of different containers, growing temperatures and production systems (bought-in or home grown plugs). Sensitivity analysis was also performed to assess the effects of variations in heating, space/time costs, levels of overheads and sales returns.

1.4 SUMMARY

1.4.1 Culture

A *Profit Margin* (see para 1.4.3) is calculated for each sowing date from week 1 to week 18 and for three temperature regimes for each crop, for 9cm pots and double six packs grown from both home grown and bought-in plugs. All combinations of these alternatives are compared assuming batches of 1000 pots or packs. The influence of a reduced sale price and 3 levels of overhead costs are also assessed. It is assumed that a marketable quality can be achieved for all batches at all temperatures.

1.4.2 Cost assumptions

The costs of seed or plugs, compost, containers, labels and the cost of labour for the main operations are allocated directly to the crops. The heating cost is calculated according to temperature and the amount of space and time for which it is required for each batch. All other costs are aggregated into an overhead charge per square metre per week. After seeking data from growers a typical figure of £1.00 per sq.m. per week was used (actual range £0.50-£1.50). It is assumed that any space saved is used for alternative cropping so the overhead charge stays the same.

1.4.3 Basic unit of comparison

Profit Margin per square metre per year: Calculating this *Profit Margin* for each batch of crop enables batches with different space and time requirements to be compared on a standard basis. It is a good measure of the profitable use of space and time. Using the *Profit Margin* per year

rather than per week reduces the need to use decimals. *Total Profit* was also determined for simulations of commercial scale production, where *Total Profit* is defined as the revenue less total costs for the quantities and crops grown.

1.5 SUMMARY OF RESULTS

1.5.1 Sowing Date

Later sowings grow faster so use less space. Overhead costs per batch are lower so the *Profit Margin* is higher.

Level of increase in *Profit Margin* from later sowing date:
High: marigolds, petunias Medium: geraniums, impatiens Low: antirrhinums, salvias

1.5.2 Growing Temperature

Crops grow faster at higher temperatures so use less space and so have lower overhead costs per batch resulting in a higher *Profit Margin*.

Level of increase in *Profit Margin* from higher temperature:
High: petunias,impatiens Medium: geraniums,marigolds Low: salvias,antirrhinums

There needs, of course, to be a suitable balance between the application of higher temperatures and light levels so that plant quality is maintained.

1.5.3 Overhead Charge

The longer the crop the greater the use of space, hence the higher the overhead cost and so the lower the *Profit Margin*. With a charge of £1.00/sq.m./week all crops and batches showed a *Profit Margin*. At £1.50 some long crops particularly, geraniums, antirrhinums and petunias, early in the season and at lower temperatures show a loss ie failed to cover variable plus overheads costs.

1.5.4 Home grown v bought-in plugs

Of necessity it was assumed that the growing time from transplanting to flowering was the same for both ie the only saving was in propagating time.

The cost of buying-in is higher than home growing and reduced the *Profit Margin*. The shorter the crop the bigger the impact on *Profit Margin* of a difference in plug costs. The impact is about the same as raising the overhead charge by £0.50. So where there is already a high cost of space then the benefits of bought-in plugs need to be looked at carefully, unless there is significant a saving in growing time.

1.5.5 Sale price reduction

Reducing the sale price has the same effect as raising costs. *Profit Margin* is reduced. However, reducing the sale price by 10% results in a smaller fall in *Profit Margin* than either a 50p rise in space cost or using bought-in plugs.

1.5.6 Ranking of husbandry systems

As a guide for growers all of the production schedules for each of the crops which produce plants for any given weak are ranked by the *Profit Margin* of each batch. A grower can therefore can look at the marketing week required and work back to the production system which suits best.

1.5.7 Overall profitability of a large scale production

This shows the predicted differences in profitablity between the production of 100,000 pots/packs of each crop over a season using different schedules. For pots of impatiens, salvias and marigolds the increase in *Total Profit* between the lowest temperature and the highest is only about £2000 (greatest profit at higher temperature), whilst the comparable figure for geraniums and petunias is about £7000. For antirrhinums it is about £4000. The differences are even greater for packs.

1.5.8 Space requirements

Shortening the growing period releases space for growing other crops. Comparison of space requirements for the large scale production of each crop at each temperature regime.

Percentage saving in space use by raising growing temperature:

Increasing temperature from:	low to medium	low to high
antirrhinums, impatiens, marigolds and salvias	about 10%	about 25%
geraniums and petunias	30%	50%

1.5.9 Comparison of heating costs

The cost of heating is an important but not a major cost to most bedding plant growers. Heating costs normally increase with higher temperatures. But if the reduction in time/space use for growing is great enough then this can sometimes more than compensate for the cost of the extra fuel. This can happen with geraniums and petunias.

1.5.10 Effects of spacing on *Profit Margin*

Unless spacing is needed to maintain market quality then, increasing the use of space increases the overhead charge and so reduces the *Profit Margin*. The extra labour cost of spacing during the growing period reduces the *Profit Margin* less than using more space by spacing out fully at transplanting.

1.5.11 Comment

Time and space have a cost on all nurseries and rank alongside labour and plant material as the major production costs for bedding plants. By recognising the importance of space and time and by using these resources more effectively greater profitablilty can be achieved. The level of overhead charge varies between nurseries and growers should work out their own cost of time and space.

Details of the relative differences in *Profit Margin* between treatments are fully described within the body of the report.

2.0 PROCEDURES AND DEFINITIONS

2.1 STANDARD FINANCIAL MEASURES USED AS A BASIS FOR COMPARISON

The scheduling models provided valuable information on growing times under a range of environmental conditions. For example, the sowing of impatiens in week 9 would take 9 weeks to reach maturity if grown on at 14'C, 8 weeks at 18'C and 6 weeks at 22'C. They will occupy the same space whilst they are growing but using 22'C instead of 14'C releases 3 weeks of production space. The aim was to calculate a single figure which could be used to compare the different growing times and which reflects the financial benefit for each crop, temperature regime etc. This should reflect the variable costs (e.g. plugs, containers, compost etc) and an appropriate allocation of fixed costs (overheads) based on the space/ time used by the crop. A full appreciation of the context of the following terms is therefore essential:

Gross margin: Calculating the gross margin (revenue less variable costs e.g. pots, compost, etc) is a relatively simple task for most crops. It is a valuable tool in planning where crops do not make significantly different demands on the overhead costs of the business or where there is unlikely to be a significant change in the scale of the business.

Heating costs: The earlier scheduling study showed that higher temperature regimes shorten the growing period for all of the subjects used. Calculating heating costs is not a simple procedure since to do it accurately requires information on the amount and time of space needed plus the cost of heating it.

Overhead Costs: It is a truism to say that sitting and looking at an empty glasshouse costs money. Many of the overhead costs are still incurred in the short term whether crops are grown or not. So even unused space has a cost. Making use of the space by cropping it attracts even more costs. Those costs are associated with the scale and type of the business and are not easily allocated to individual crops. They can however be allocated to the production space of the buisness and so become the cost of space for that business.

In order to make valid comparisons of husbandry techniques which make differential use of space requires that all of these overhead factors need to be considered. Ideally they need to be incorporated into one figure. An overhead cost per square metre per week was therefore calculated. This value can then be used to assess the cost of the space and time required for the production of a crop. A crop grown over a shorter duration will therefore have a lower total overhead cost than one grown over a longer period, e.g. at lower temperature. It is important to appreciate that the allocation of overheads in this way is only valid if the overall level of use of time and space on the nursery remains about the same. If for example, less time and space is used then the assumption must be made that other crops will be found to use the gap created so that the saved space can be allocated to them. If by growing a crop faster a period of say 3 weeks is saved, then for an economic benefit to be realised, this time must be used for another crop. If it goes unallocated then it needs to be accounted for by an increase in the cost of space per square metre.

For instance, if the overhead cost per square metre per week is say £1.00 and the crop takes

9 weeks then the cost per square metre of crop production for the 9 weeks is £9.00. If the growing time if reduced to say 6 weeks but the saved time and space is still unused the total costs is still £9.00. For the space actually used the unit cost would rise to about £1.50 per square metre per week.

For the purpose of these comparisons it is assumed that any space saved is fully used in other cropping. However any extra income produced by the new crop was not included in the comparisons. This approach is most valuable at times of peak production when space is at a premium. At other times of the year when space is not resticting it does not matter how long a crop takes (within reason) because there is no other crop competing for the space and so there is no saving to be made. However, in practical even when space is not at a premium it is beneficial to speed up a crop as it saves time, labour, water, chemicals and reduces risk.

2.1.1 Calculation of Profitability

The basis of the calculations was the production of both 1000 9cm pots and 1000 double six packs. The method of calculating profitability adopted in this study was as follows:

i. Firstly, sales revenue was determined.

The following costs were then deducted:

ii. Easily calculated variable costs eg seed/plugs, compost, containers, labels etc.
iii. The cost of maintaining the required temperature regime at different periods of the year were calculated.
iv. The costs of the major labour operations of sowing, transplanting, spacing and marketing were assessed.
v. The overhead and other unallocated costs were then allocated according to the space used by the crop.

The resulting figure can be described as a *gross margin less allocated fixed costs* or as *a Profit Margin per crop*. However, it relates to crops or sowings with varying lengths of growing periods and space use. In other words varying time/space requirements eg square metre/weeks. To arrive at a comparable figure for different production systems we therefore need to divide the *Profit Margin per crop* by the time/space requirement. This determines the *Profit Margin* per metre per week. To avoid the use of decimals and highlight differences more effectively, this was then multiplied by 52 and converted to "*Profit Margin* per Square Metre per Year"

2.1.2 "Profit Margin per Square metre per Year"

"Profit Margin per Square Metre per Year" was used as the basis for the comparison of the various husbandry systems included in the scheduling study. For ease of use however it will be shortened to "*Profit Margin*". A broadly similar overall figure could be derived by dividing the profit from the trading account on a nursery by the average area of glass used

during the year.

2.1.3 *Profit Margin* Comparisons

The basis unit of production for these comparisons was 1000 9cm pots and 1000 double six packs. In order to avoid distracting discussion of predicted profit levels, none of the actual values calculated have been used in this report. Instead they have been reduced to relative differences so that direct comparisons of the effects of temperature, levels of overhead charge, the origin of plugs used and price sensitivity can be measured.

Unless otherwise specified the majority of figures quoted refer to differences in the *Profit Margin* in £ per Gross Square Metre per Year. The base or bench mark figure against which others are compared is represented as "0" and the actual divergence from the base is calculated. For example if the baseline crop has a *Profit Margin* of £50 it will be assigned a value of 0. A second crop with a *Profit Margin* of £60 would be assigned the difference i.e. £10 as its value. Furthermore, if a comparable figure is less than the base then it appears as a negative. This does not mean that the batch in question has made a loss merely that it was lower than the comparable base figure.

However, as an indicator, where a calculated *Profit Margin* was in fact negative ie (an actual loss) the resulting indices are shown inside a bracket. For example, in the above illustration (60) would indicate that the figure represents a calculated loss of £10 per square metre per year rather than a profit.

This method was chosen in preference to percentages which vary enormously when the base figure is either small or negative. The following *Profit Margin* comparisons are made for each crop.

Effects of temperature;

i. Comparison of relative *Profit Margins* for the different sowing dates within each temperature regime.

ii. Comparison between temperature regimes by sowing date.

iii. Effects of varying level of overhead costs.

iv. Effects of varying sale price levels.

v. Effects of buying in plugs viz home grown.

vi. The ranking of husbandry systems by sales period and by profitability.

2.1.4 Comparisons of commercial scale volumes of production

In order to give a broader comparison of the economic implications of the schedules the narrow concept of "*Profit Margin*" has been extended to include a measure of predicted profitability for larger volumes of production. Large volumes have been used to show more clearly the relative differences between systems.

i. Total Profitability of All Batches:

For this comparison it is assumed that 10,000 pots or packs are produced for each of 18 sowings at weekly intervals (batches) at each temperature and plug source (ie a total of 180,000 units). The *Total Profit* calculated was the total profit, i.e. the total revenue less total costs, not the *Profit Margin* related to the area used. The extra profit or loss is a direct reflection of the balance between heating fuel costs, space/time costs and the differential impact of plug source. However, it does not take any account of any revenue from the additional space available for extra cropping because of the shorter growing periods at the higher temperatures.

ii. Total Profitability of Typical Production Schedule:

In practise the marketing pattern of sales generally builds up in mid April, peaks in May and drops off to mid June. This gives approximately a eight week sales period. Each year it will vary in both timing and length depending on the season. Comparisons were therefore made to determine the *Total Profit* of various strategies (temperature/use of plugs etc) to produce crops according to a commercial schedule. For this comparison a total of 100,000 units was used but the following percentage distribution (schedule) assumed.

Week Number	17	18	19	20	21	22	23	24
% Distribution	7	14	14	7	22	22	7	7

This distribution is for illustration only and indicates only one possible sales pattern. The dip in week 20 is deliberate to represent the frequent hiccup in sales through lack of supplies after the initial build of sales. In effect it can be taken that each percent unit equates to 1,000 units of production.

3.0 DATA USE: ASSUMPTIONS

3.1.1 Propagation: Plugs

All crops were assumed to be grown from plugs (home grown and bought-in).

Home Produced Plugs: Germination was assumed to take place in 576 trays for all crops. A propagation temperature of 18'C was assumed for the propagation of the home grown plug for all crops. For most of the crops, the germination period from sowing up to transplanting was about 3 weeks. This was an average over all of the batches sown from week 1 to week 18. Naturally it was slightly longer earlier in the season and shorter later but as a time unit of one week was used fractions of less than a week could not be accommodated.

Bought-in Plugs: These were assumed to be the same size and stage of development as the home grown plugs. It was assumed that the period from transplanting to sale would be the same for both home grown and bought-in plugs. It was recognised in practice that there would be differences. In order to standardise the comparison between home grown plugs and bought-in plugs it was assumed that batches produced from bought-in plugs, but transplanted at the same time as those grown from home grown plugs, would be given the same sowing dates (batch) designation.

3.1.2 Growing period:

The result of a standard 3 week germination period is that the post-transplanting growing period was considered to be the time from sowing to maturity less three weeks. The growing period for both pots and packs was the same.

3.1.3 Temperature regimes:

From the plug transplanting stage to sale, plants were assumed be held at the temperature prescribed for the schedule.

3.1.4 Spacing:

Three options were considered. Pots of all crops were assumed to be;

i) Set out pot thick for the whole of the growing period after transplanting
ii) Pots of geraniums were assumed to be set out pot thick and then spaced in their growing trays. To achieve this 6 pots were taken from the 15 in the tray and placed elsewhere.
iii) Pots of geraniums were assumed to be set out at final spacing immediately after transplanting.

For packs;

i) Packs of all crops were set out at final spacing, pack thick, immediately after transplanting.

ii) Packs of Geraniums were also started off pack thick then be spaced at a set time in the growing period.

3.1.5 Sales:

Sales were assumed to take place in the week in which the crop flowered and were completed within that week.

3.1.6 Wastage:

A standard 5 percentage wastage has been used for the growing phase for all crops. Wastage during home grown propagation has been set at 76 plugs from a 576 tray.

3.1.7 Quality:

It was assumed that all plants were of saleable quality for each batch of crop. The wastage figure above includes that proportion of a crop which fails to reach the required quality standard. There was only one sale price for each pack or pot for each crop.

3.2 Crop Scheduling Data for Individual Crops

3.2.1 Crops:

Scheduling data was determined for each of the following crops: antirrhinum, geranium, impatiens, marigold, petunia and salvia.

3.2.2 Temperatures:

Schedules were provided for 5 temperature regimes for each crop, but due to the volume of data this was reduced to 3 before processing.

3.2.3 Number of sowings:

18 sowing weeks for each crop.

3.2.4 Timings:

The schedule for each crop and temperature indicated the week number of sowing, the week number of transplanting, the week number for spacing (where appropriate) and the week of flowering (which was taken as the week of sale).

3.3 Production Material and Cost Assumptions

It was recognised that the prices paid for individual inputs can and do vary enormously from grower to grower, supplier to supplier and from one time to another. The procedure followed in obtaining input costs has been to use catalogue prices for all items discounted for large quantities. Following consultation, it was decided not to disclose the actual prices used in the project.

3.3.1 Varieties:

The same variety has been used as in the original scheduling work at The University of Reading. A typical price for both seeds and plugs has been established using the heavily discounted catalogue prices for plugs and seed from one seed house.

3.3.2 Packs or Pots:

Prices for pots, double six packs, growing and marketing trays were established from growers.

3.3.3 Plug trays:

Although home grown plugs did use plug trays no cost was included because it would have been such a small figure. It was therefore included in the overhead costs.

3.3.4 Compost:

Ready mixed peat based seed and growing composts has been assumed. The volumes of compost used in propagating trays, packs and pots have been calculated.

3.3.5 Chemicals:

No attempt has been made to allocate typical fertiliser, insecticide and fungicide costs to each crop or batch. These items have been included in the overhead costs.

3.3.6 Marketing costs:

The number and type of labels to be used plus their unit cost were established from growers. A standard 18 pot marketing tray was assumed.

3.3.7 Heating Costs:

A light oil price has been used and the cost of heating is allocated to each batch of each crop. The same ambient temperature regime has been used for all fuel cost calculations.

3.4 LABOUR USAGE AND COSTS

The labour requirements for the main production and marketing operations have been used, as determined from the grower survey. These have been based on an efficient sowing and transplanting line, together with typical labour use for spacing and marketing. The search for labour rates has highlighted the dearth of reliable information in this field. Very few growers could quantify the amount of labour used on even some of the major tasks.

3.4.1 Sowing:

This covers the filling of trays, sowing of seed and the laying down of trays. The man hours required per 1000 units of production ie pots and double six packs was estimated following discussions with growers.

3.4.2 Transplanting:

This includes container filling, transplanting, and setting down.

3.4.3 Preparation for sale:

This operation extends from picking up, through cleaning, checking and loading onto the marketing trolley.

3.4.4 Spacing

Times for actual spacing operations have been used. For all of the above direct production operations two average labour costs have been used. The first reflects the payment to casual workers and is used for transplanting and spacing. The second, higher one, assumes that regular labour is used for sowing and preparation for sale.

3.4.5 All other Labour

This includes watering and plant care and is included with the overheads and is distributed on a per square metre per week basis.

3.5 OVERHEAD COSTS

The aim has been to allocate all non allocated variable costs and fixed costs in such a way that reflects the use of space by each batch of each crop during its growing period. For example, if a crop occupied 1 square metre for 1 week it would be charged say £1.00, if it occupied that same space for 10 weeks it would be charged £10.00. An overhead cost per square metre per week of production area was derived so that a realistic cost of space and time could be included in the crop costings. The following procedure was used to arrive at typical figures.

3.5.1 Total Annual Overhead Charge:

A number of growers were asked to provide annual cost information for their nurseries as a whole. From these, costs of plants and seeds, compost, containers, heating, labels and growing and marketing trays were deducted. Finance charges were also excluded on the grounds that they reflected the financial circumstance of the business rather than its production. The residual figure therefore includes all labour, chemicals, sundries and all other overheads eg machinery costs, depreciation, rates etc.

The inclusion of all labour costs in the overhead charge per square metre whilst at the same time calculating the costs of individual operations means that there is an element of double counting. This is recognised, but it's exclusion was deemed to be too complex an operation to warrant the marginal precision it would bring.

3.5.2 Percentage Space Utilisation:

The same growers were asked to calculate the space utilisation (ie the actual growing area compared to the total glasshouse area on the nursery). For example, a nursery may have a protected area of 2000 square metres but the beds / tables may only occupy 85% or 1700 square metres.

3.5.3 Percentage Annual Utilisation:

The proportion of the nursery (gross area) which is used during the course of the year varies with the type and variety of production. Growers were asked to estimate the percentage use for each month of the year. Typically the percentage use was low in January building up to full occupancy in March then falling off between July to September. These figure were then used to obtain an average percentage use for the year as a whole.

3.5.4 Average Area Used:

The gross area, space utilisation and the annual percentage utilisation were then multiplied to determine the average used growing area in metres.

3.5.5 Overhead Cost Per Square Metre Per Week:

The annual overhead charge was then divided by the average used area to calculate a cost per square metre per week. Thus, the overhead cost was weighted according to the intensity of production. The more efficient the space utilisation, the lower the costs per square metre.

3.6 Scale of Production

It was anticipated that the overhead costs per square metre would vary with the scale of operation and the type of production. Costs were obtained from large, medium and small specialist bedding plant producers. A median figure of about £1.00 per square metre per

week was calculated for nurseries of all three sizes. Overall the overhead costs obtained varied from about £0.50 per square metre to about £1.50. This range was not related to size of holding. As a consequence £1.00 has been used as the base figure with both £0.50 and £1.50 also being used in a sensitivity analysis.

4.0 INTERPRETATION OF RESULTS: IMPATIENS

As indicated previously the measure of profit used for this study is the *Profit Margin* per square metre per year ("*Profit Margin*") for one thousand pots or packs. This has been calculated for each sowing date of each crop ("batch"). These have been converted to differences with a base of "0", (see paragraph 2.1 for further explanation).

Rather than attempt to present the data for all 18 sowings per "treatment", batches 1, 9 and 18 are used in summary form below. Unless otherwise stated the comparisons are based on the data from the regimes using home produced and bought-in plugs and with an overhead charge of £1.00 per square metre week.

The detailed analysis given below is for the impatiens schedule which has been used as an illustration and provides a bench mark against which the other crops can be assessed. Data for other crops are in the appendicies.

4.1 EFFECTS OF TEMPERATURE:

4.1.1 Effects of Changing Sowing Dates Within Each Temperature Regime on the Duration of Production:

The duration of the time of production and the relative differences between sowing dates and temperatures are shown below and in Figure 4.1.1.

Home Grown Plugs		*Growing Period Weeks*				
		14'C	*16'C*	*18'C*	*20'C*	*22'C*
Sowing week	1	11	10	9	8	7
	9	9	8	8	7	6
	18	7	7	6	6	6

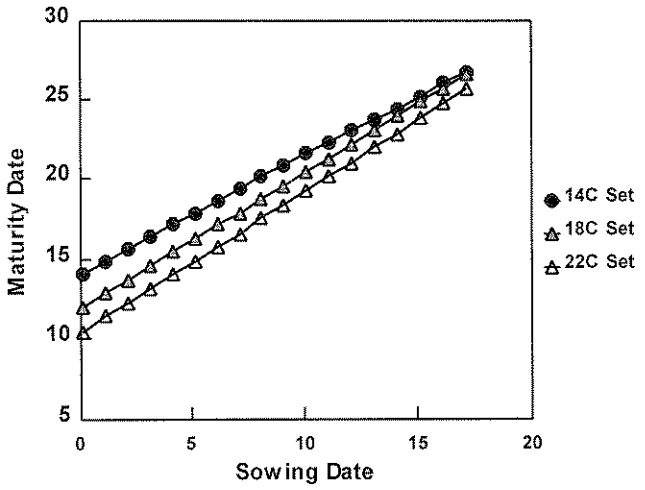


Figure 4.1.1 The sowing date schedules for impatiens grown at 3 different temperatures, dates are week numbers.

Thus, the duration of production varied from 11 weeks for early sowings at 14'C to 6 weeks for the last sowing and highest temperature regime (22'C from week 18). The unevenness in the relative percentages is a result of rounding the actual growing times into weeks. In view of the above and the need to reduce the volume of data being analysed, only the results for 14'C, 18'C and 22'C treatments are discussed in detail in the rest of this report.

		Growing Period as % of week 1			*Temperature as % of 14'C*		
		14'C	18'C	22'C	14'C	18'C	22'C
Sowing week	1	100	100	100	100	82	64
	9	82	89	86	100	89	67
	18	64	67	86	100	86	86

This second table shows the percentage change for each temperature when later sowing dates are compared with week 1. The lower the percentage the bigger the reduction. There is a bigger relative reduction through the season at the lower temperature. The progressive reduction with temperature increase is similar for sowings in both weeks 1 and 9, but in week 18 there is no difference between 18'C and 22'C.

4.1.2 Comparison of the *Profit Margin* for the Different Sowing Dates Within Each Temperature Regime.

For this comparison the *Profit Margin* for batch 1 in each growing system, temperature and container has been converted to "0" and the other figures adjusted accordingly. This allows the trend in profitability to be seen clearly as the season progresses. The table below shows the differences in *Profit Margin* of impatiens grown at 14, 18 or 22'C, in either pots or packs and with different sowing dates. Comparisons should not be made between temperatures, for this see para 4.1.3.

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	0	0	0	0	0
	9	22	17	27	24	19	29
	18	54	59	31	58	63	33

These results for pots are presented graphically in Figure 4.1.2, and show that the *Profit Margin* increases dramatically with later sowings. A similar relationship was found for double six packs.

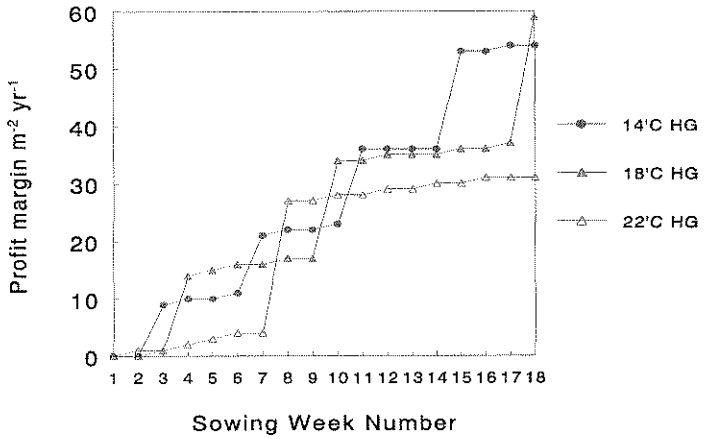


Figure 4.1.2. The relationship between sowing week number, temperature and *relative Profit Margin* for pot impatiens from home grown plugs, assuming an overhead charge of £1.00 per square metre per week, data normalised to batch 1 as "0", for all temperatures.

The growing times can be summarised as follows: At higher temperatures a shorter time is required to reach maturity, however, this benefit falls away with later sowings as ambient temperatures (and light) increase during the year. These trends are repeated in an exaggerated form in the movements of *Profit Margins*. The bigger the reduction in growing time the greater the increase in *Profit Margin*. Figure 4.1.2 illustrates this well. The sudden atypical jump in *Profit Margin* for batch 18 at 18'C, is probably attributable to rounding the schedule times to whole weeks rather than any major change in profitability.

4.1.3 Comparison of the *Profit Margin* for Different Temperature Regimes by Sowing Date.

The changes in relative profitability of each sowing date over the three temperature regimes during the growing season are compared. In this comparison the *Profit Margin* for all batches grown at 14'C using home grown plugs have been used as the base ("0") and the other two regimes for the same sowing are compared with it (see below).

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	16	42	0	17	46
	9	0	11	47	0	12	51
	18	0	21	19	0	22	21

Details are shown in Figure 4.1.3.

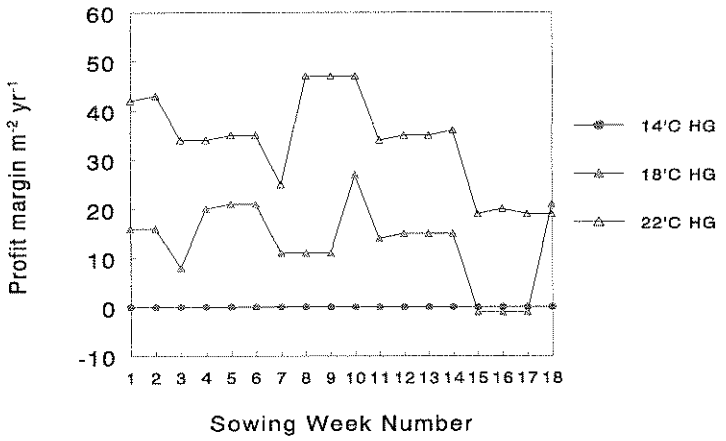


Figure 4.1.3 The effects of temperature and sowing week on *relative Profit Margin* for pot impatiens, grown from home grown plugs at an overhead of £1.00 per square metre per week. Data are normalised with the 14'C *Profit Margin* set at "0" in each week.

The trends in *Profit Margins* for both pots and packs between temperatures in weeks 1 and 9 are similar, with increased *Profit Margins* being found at higher temperatures; *Profit Margin* more than doubled as temperature increased from 18 to 22'C. However, with the week 18 sowing the differences are less marked. The increased *Profit Margins* at higher temperatures no doubt reflects the shorter growing period and the resultant lower relative overhead cost per crop.

Thus, the shorter the growing season the greater the *Profit Margins*. As the only variables are the heating costs and the amount of space/ time used then it shows that the cost of space is much more important than the cost of heating.

4.2 Effects of Varying The Level of The Costs of Space (Overheads).

Using the overhead charge of £1 per square metre per week as the base, the effect of varying the charge from £0.50 to £1.50 was assessed. If for example the *Profit Margin* for sowing batch 16 at 18'C for pots is say £80 then the comparable figures with overhead charges of in

turn £1.50 and £0.50 are £54 and £106. The reason is straightforward.The only variation in this comparison is the +/- £0.50 change in overhead charge per square metre week. As the *Profit Margin* is the profit margin per squre metre per year. Over a year this is equivalent to £26.00. This relativity applies which ever the combination of pots, plugs and temperatures are compared at the different levels of overhead charge.

Thus, the *Profit Margin* is highly sensitive to the level of overhead. Increasing the overhead from £1 to £1.5 per square metre per week reduces the profit on a batch of 1000 plants by £26. It follows therefore that if the *Profit Margin* is known at any level of overheads then the effect of a change in overheads can be calculated, assuming of course that this is the only change.

The impact of lowering the *Profit Margin* by £26 is considerable. For home grown plugs all batches result in a *Profit Margin*. However as will be seen later when plugs are bought-in then some of the early batches are loss making. Thus, the lower the overhead charge the higher the *Profit Margin* and conversely the higher the charge the lower the *Profit Margin*. The longer the crop the greater the impact of higher overhead charges.

4.3 Effects of Buying-in Plugs viz Home Grown:

All of the above comparisons have also been made for crops grown from bought-in plugs. Since the only other differences are the cost of propagating compost and sowing time, it is not surprising that the real effect arises from the cost differences between seed and plugs.

Note: when using bought-in plugs no allowance has been made for the saving of space in the propagating stage, nor is there assumed to be any difference in growing time post transplanting.

The table below and Figure 4.3.1a and b show the differences in *Profit Margin* for pots and packs produced from home grown or bought-in plugs when grown at one of three different temperatures. In each case data are normalised to the *Profit Margin* of home grown plugs grown at the same temperature and on the same sowing date. The table below shows the reduction in *Profit Margin* when bought-in plugs are used.

Comparison of the difference in Profit Margin between plug sources: Reduction in Profit Margin when bought-in plugs are used

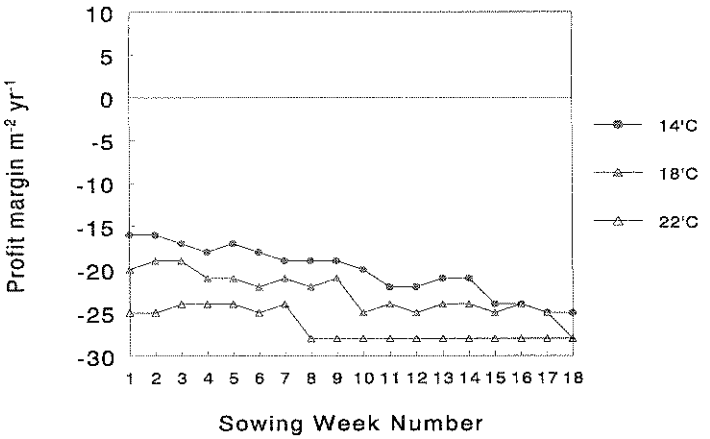
		Pots			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	-16	-20	-25	-26	-31	-40
	9	-19	-21	-28	-32	-35	-46
	18	-25	-28	-28	-40	-46	-46

Note that although the table shows negative values these do not represent an absolute loss in monetary terms, just a reduction in profit relative to the use of home grown plugs produced at 14'C. *Profit Margins* were lower from bought-in plugs than from home grown.

The reduction in *Profit Margin* resulting from the use of bought-in rather than home grown plugs, increased with temperature and sowing date, i.e. the shorter the growing time the greater the penalty for using bought-in plugs. The impact of bought-in plugs is greater with packs since the pack sale price in relation to the cost of the plug is smaller. For example, when the sale price for a pot impatiens is divided by the bought-in plug price the resulting multiplier is greater than when the same calculation is made for packs.

When other pressures are placed on the *Profit Margin* e.g. increased overheads then the impact of the cost of the plugs becomes greater. For example, when bought-in plugs are used and the overhead charge is raised to £1.50 then absolute losses are calculated for the batches sown between weeks 1 and 5 and grown at 14'C and for sowings in the first three weeks of the year at 18'C. At 22'C all batches are profitable. In practice this seems to mean that at 14'C batches growing from bought-in plugs which take ten weeks to grow are unprofitable, whilst at 18'C this applies to batches that take 9 weeks to grow.

Pots



Packs

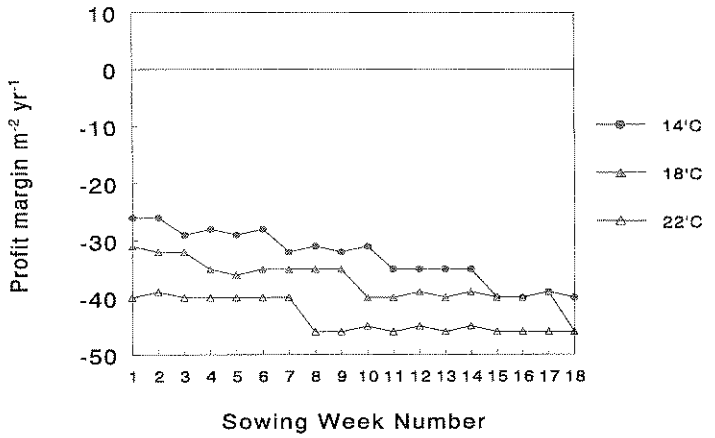


Figure 4.3.1. The reduction in *relative Profit Margin* when bought-in plugs are used for pot (4.3.1.a) and pack (4.3.1b) *impatiens* at an overhead charge of £1.00 per square metre per week. Data for crops grown from bought-in plugs normalised with the *Profit Margin* for comparable crops from home grown plugs set at "0".

4.4 Effects of Varying Sale Price Levels:

4.4.1 Actual Difference in Profit Margin between Standard Price and 10% Reduction

The impact of reducing prices has also been assessed. Two levels of price are compared. The standard is £0.35 for pots and £2.50 for packs and then a reduction of 10% on both. In reality this means that the pots were reduced to £0.315 and the double six packs to £2.25.

The table below and figure 4.4.1 (for pots only) show the reduction in *Profit Margin* caused by the price by 10%, data are normalised to the comparable *Profit Margin* at the standard price for each combination.

Reduction in Profit Margin when sales prices are reduced by 10%

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing Week	1	-12	-15	-19	-14	-16	-21
	9	-14	-16	-21	-17	-19	-24
	18	-19	-22	-21	-21	-24	-24

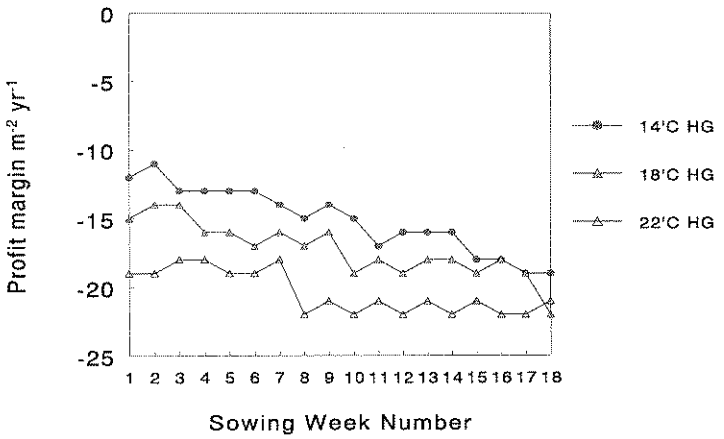


Figure 4.4.1. The effects of a 10% reduction in price of pot impatiens expressed as actual differences compared with the *relative Profit Margin* at the full price.

For both pots and packs the decrease in *Profit Margin* due to price reduction is on average greatest in the 22'C regime, with the smallest effect being seen in the earliest of the crops grown at 14'C. It would appear that the smaller the space/time requirement of the crop the greater impact price variations have. This is because the reduction is spread over fewer weeks and so appears higher.

4.5 RANKING OF HUSBANDRY SYSTEMS BY PROFITABILITY:

So far all of the comparisons have been made using the sowing week of the batches. In reality growers are more concerned with the maturity or selling date. With this in mind all of the batches in all of the temperature regimes and methods of plug procurement have been re-ordered according to time of maturity and in terms of relative *Profit Margin*. For example, all husbandry methods with product ready from sale in say week 20 are grouped together and their *Profit Margin*s compared using actual *Profit Margin* differences.

In order to assess any changes in the relative profitability of the systems between the sales week, a ranking system was been devised. Thus, a descending order of ranking from 1 to 6 was applied to the growing systems in sale week 20 (a peak week in the season). These figures have been kept constant for their growing system in week 20 all other sales weeks. Any variation from strict mathematical progression in week 17 and 23 indicates a change in the relative profitability of the different production systems. Where a ranking figure is duplicated in the same week this means that more than one sowing for a particular system of growing will produce plants ready for sale in the same week.

In order to emphasise the differences in production times between the batches the actual production time from transplanting to flowering is given for each batch.

Growing systems were ranked according to their *Profit Margins*, within each maturity week data are normalised to the *Profit Margin* of the least most profitable system.

Pot Production

Maturity Week	Sowing Week	No Weeks Growing	Growing System	PM Ranking At Week 20	Relative PM Value
17	9	6	22HG	1	76
	9	6	22Buy	**3**	48
	7	8	18HG	**2**	39
	7	8	18Buy	4	18
	5	10	14HG	5	17
	5	10	14Buy	6	0
20	12	6	22HG	1	68
	11	7	18HG	2	47
	12	6	22Buy	3	40
	11	7	18Buy	4	23
	9	9	14HG	5	19
	9	9	14Buy	6	0
23	15	6	22HG	1	57
	14	7	18HG	2	36
	15	6	22Buy	3	29
	13	8	14HG	**5**	21
	14	7	18Buy	**4**	12
	13	8	14Buy	6	0

Thus, for any maturity week there were very substantial differences in the *Profit Margin* of batches, for example, with plant maturing in week 17 there was a £76 increase in *Profit Margin* of plants grown at 22'C from home produced plugs compared to plants at 14'C from bought in plugs. The change in ranking indicates the changing emphasis on temperature during the season. Initially 22'C, whether from home grown or bought-in plugs, was the most profitable but as the season progresses firstly 18'C home grown overtakes 22'C bought-in and then 14'C home grown overtakes 18'C bought-in.

In practise though it is unlikely that a grower will have the flexibility to change temperature regimes on a short term basis. So if one temperature only is used then it is better to produce home grown plugs, unless a reduction in growing time can be demonstrated from using bought-in plugs.

4.6 OVERALL PROFITABILITY OF SYSTEMS:

4.6.1 Total Profitability of All Batches:

For this comparison it is assumed that 10,000 pots or packs are produced for each batch of plants sown each week for 18 weeks, ie 180,000 total.The *Total Profit* calculated was the total one (i.e. total revenue less total costs) and not related to the area used. Equally the negative figures indicate an actual *Total Profit* lower than the 14'C crop from home grown plugs and does not mean an actual loss has been incurred.

Differences in Total Profit (£000's) *compared with 14'C (Home Grown)*

	14'C		*18'C*		*22'C*	
Plug Source	*HG*	*Buy*	*HG*	*Buy*	*HG*	*Buy*
Pots	0	-7	2	-5	4	-3
Packs	0	-83	14	-69	30	-54

Each unit of difference is £1000. The highest *Total Profit* were reported for the double six packs grown at 22'C from home grown plugs. Differences between treatments were again substantial with the bought-in packs grown at 14'C producing £113K less *Total Profit* than the 22'C home grown plugs. The extra *Total Profit* or loss is a direct reflection of the balance between heating fuel costs, space time costs and the differential impact of plug source.

Note: It does not take any account of the extra space available because of the shorter growing periods at the higher temperatures.

4.6.2 Profitability of Typical Production Pattern:

Here 100,000 units are produced according to a typical sales pattern, described in section 2.1.4.

Differences in Total Profit (£000's) compared with 14'C (Home Grown)

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-4	1	-3	2	-2
Packs	0	-46	9	-38	18	-28

The differences here are less marked than in 4.6.1 above, especially for the pots. Thus, the profitability of home grown plugs raised at 22'C was £6K greater than bought-in plugs produced at 14'C. The reason is probably that less emphasis is placed in practice on the early production and so the growing periods are shorter for all temperatures.

Overall the estimated difference in *Total Profit* between the production of pots from home

grown plugs at the three temperatures is not very great. However, this takes no account of the space saved and the opportunity for extra crops. The bigger difference lies between plug sources. For packs however there is still a significant difference between temperatures and between plug sources.

However, it should be remembered that if the crop is produced at 22'C then the earliest sowing was required in week 9 compared to week 7 for the crops produced at 18'C and week 5 at 14'C. Consequently, crops grown at higher temperatures leaves an extra 2 to 4 weeks in the early part of the season when an extra crop may be grown for the market. This extra crop would lead to higher *Profit Margins*, from the increased returns and relative reduction in overhead costs, by sharing these costs with the extra crop.

4.6.3 Space Requirements of Typical Production Pattern.

Figure 4.6.3 shows the space requirement, in square metres, of 100,000 pots grown at the 3 temperatures to achieve the typical sales pattern. The space requirement is the same for the last 6 weeks of cropping. However, there is a marked difference at the beginning of the season. It appears that for every 4'C rise in temperature there is a saving of about 2 weeks on the growing period. This has a significant effect on the different space needs of the three temperature regimens, as seen in Figure 4.6.3.

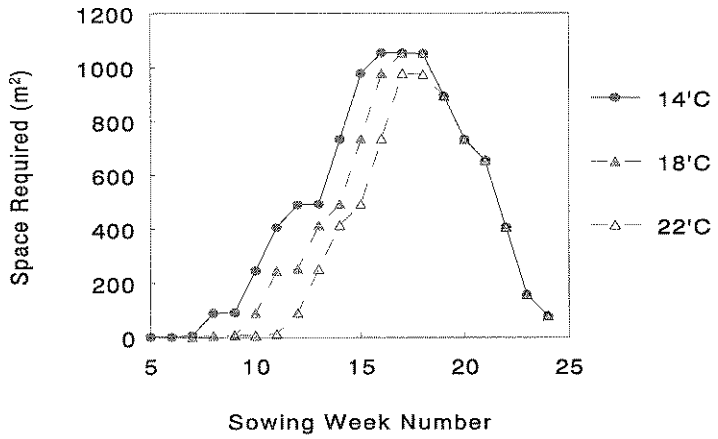


Figure 4.6.3 The area required for a typical production pattern for 100,000 pots.

If, for each temperature regime, the total number of square metres used during the growing period of all three batches are added together they can be compared.

Space Requirements of a Typical Production Pattern as a percentage of 14'C.

Temperature	*14'C*	*18'C*	*22'C*
Pots	*100%*	*86%*	*72%*
Packs	*100%*	*86%*	*72%*

Pots and packs are the same because the same cropping schedule is used for both.

In practice the above figures mean that the temperature shortens the growing period but also as a consequence reduces the overall space requirements of the crops. This in turn releases more space for increased production.

4.7 COMPARISONS OF VARYING COSTS OF FUEL

The table below shows the estimated amount and cost of fuel used if 4000 square metres of glass were heated at the different temperatures for a year.

	14'C	*18'C*	*22'C*
Litres 000s	108	161	223
Cost (@ 13p/litre) £000	14.1	20.9	29.0
Percentage difference	100	148	205

The actual cost differences are significant and raising temperatures needs to bring significant returns to cover the extra cost. For most nurseries the cost of fuel is not one of the most important cost items. It represented only about 5% of total costs on the nurseries questioned. Plants/seed and labour are of much greater importance. Its impact on profitability is therefore lessened particularly if the cost of space is included.

At 4.6.2 above *Total Profit* differences are given for 100,000 pots grown at the three temperatures. The table below calculates the same figures assuming that fuel costs were changed by +- 20% and by +50%. Increasing the fuel cost by 50% has only a minimal impact on the *Total Profit* for the pots. For packs, although the fuel cost increase has a slightly longer impact, it is still small in relation to the size of the *Total Profit*.

Differences in Total Profit (£000's) compared with 14'C.

Home Grown Plugs		*Pots*			*Packs*		
		Total Profit difference			*Total Profit difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
		£	£	£	£	£	£
Cost per litre	13p	0	1	2	0	9	18
	-20%	0	1	2	0	9	18
	+20%	0	1	2	0	9	18
	+50%	0	2	3	0	8	17

This shows that varying the temperature has a greater impact on profitability than even significant increases in fuel prices. It also demonstrates the greater space/time requirements of packs viz pots.

The table below shows the same data but reanalysed in terms of the effects of an increase in fuel cost on the *Profit Margin*. Data are normalised to the value for each fuel cost at 14'C.

Differences in Profit Margin compared with 14'C

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Cost per litre	13p	0	17	42	0	19	46
	-20%	0	17	42	0	19	46
	+20%	0	17	41	0	18	45
	+50%	0	17	41	0	18	44

The comparison of the *Profit Margin* differences for the varying fuel prices shows the relatively small change which arises from significant price changes.

5.0 ALL CROPS: SUMMARY OF RESULTS

The following comments refer to all of the crops. A detailed description of the responses of each of the individual crops other than impatiens can be found in the appendices. This chapter summarises and contrasts the response of all six crops. Although many of the physical responses used in this study may be self evident, the economic implications of these responses are no so obvious, nor have they been quantified previously.

5.1 EFFECTS OF TEMPERATURE:

5.1.1 Effect of Sowing Dates and Temperature on Growing on Time

All crops were grown at 14'C, 18'C and 22'C with the exception of antirrhinums. These were grown at the more suitable temperatures of 10'C, 14'C and 18'C .

The time to maturity of all crops decreased with increasing temperature, especially those sown early in the season (see table below). For all crops there was also some improvement to be gained from increasing from the medium to the higher temperature.

Reduction in growing time in weeks by increasing temperature from the lowest to the highest (e.g. 14' to 22'C or 10' to 18'C, etc).

Sowing date	Impatiens	Antirrhinums	Geraniums	Marigolds	Petunias	Salvias
Week 1	4	3	6	3	6	3
Week 9	3	2	4	1	4	2
Week 18	1	1	1	1	2	1

Petunias and geraniums showed the greatest response to temperature, early in the season followed by impatiens.

- The higher the temperature the shorter the growing time. The later the sowing date the shorter the growing time.

There needs, of course, to be a suitable balance between the application of higher temperatures and light levels so that plant quality is maintained.

5.1.2 Comparison of the *Profit Margin* for the different Sowing Dates.

This study has shown that slow crops such as petunias, salvias and antirrhinums occupy space

for longer periods compared with impatiens and marigolds, and therefore incur higher space/ time costs. Geraniums which are slow early in the season but much quicker late in the season have widely differing space usage depending on crop timing. Thus, the *Profit Margin*[1] is directly affected by the use of and cost of space. In consequence, it is affected by the length of the growing period and so by any changes in the use of space resulting from sowing date and temperature. When a cost is applied to the use of space/time, the length of cropping becomes very important. The longer the crop the greater the impact on the *Profit Margin.*

The *Profit Margin* rose steadily for all crops for all temperatures rose as the length of the growing period fell from week 1 to week 18. The tables and graphs in the report show the weekly increase over the *Profit Margin* in week1. The increases in *Profit Margin* range from a mere £5.00 for salvias in week 9 at 18'C to a massive £135 for marigolds at 22'C. The impact of sowing date for crops can be ranked, in terms of increase in *Profit Margin*, from later sowing date, as follows:

High:	Medium:	Low:
marigolds and petunias	geraniums and impatiens	antirrhinums and salvias

- For all crops and temperatures the later the sowing date the shorter the growing period and the greater increase in *Profit Margin*, though this varies with crop.

5.1.3 Comparison of Relative *Profit Margins* between Temperature Regimes

The *Profit Margin* increases as the growing period becomes shorter. Hence, the *Profit Margin* for each of the crops increases with temperature for virtually all sowings and species. The increase in *Profit Margin* from higher temperatures are greater early in the season, but for most crops there is a fall away at the end of the season. The exception to this is antirrhinums for which there is a fairly constant increase in *Profit Margin* with temperature throughout the season.

The response to temperature for crops can be ranked, in terms of increase in *Profit Margin*, as follows:

High:	Medium:	Low:
petunias and impatiens	geraniums and marigold	salivas and antirrhinums

- The higher the temperature the shorter the crop, the greater the *Profit Margin.*

[1]For the purpose of this report "*Profit Margin*" is the profit margin per square metre per year (see 2.1) for each batch of the crop.

5.2 Effects of Varying The Level of The Costs of Space (Overhead Charge[2]):

For this study a standard weekly overhead charge of £1.00 per square metre/week has been used as the cost of space. When the calculated actual *Profit Margin* is positive then that batch is contributing to the profit of the business. When it is negative it means that it is not covering all of the overheads. None of the batches studied produced a *Profit Margin* so low that they failed to cover even the direct costs of production.

All pot crops showed a *Profit Margin* at all temperatures and virtually all batches when a charge of £1.00 is used. The only exceptions to this were for the first batch of the bought-in plugs grown at 14'C for geraniums, petunias and marigolds. For packs of geraniums, petunia and marigolds a number of the early batches at the lower temperatures failed to achieve a *Profit Margin.*

If the level of overhead charge is changed without altering other factors then the effect on the *Profit Margins* for all batches of all crops, at all temperatures will be the same. Increasing the overhead charge from £1.00 to £1.50 per square metre week reduces the *Profit Margin.* The impact of this depends on the initial *Profit Margin* of the crop, such an increase could mean that there was a negative *Profit Margin* i.e. not all costs were recovered.

The following table summarises the first week in which a positive Profit Margin is calculated. when the overhead charge is £1.50 per square metre per week.

Crop	Home grown plugs: Pots			Home grown plugs: Packs		
OverheadCharge £1.50/sq.m/week	14'C	18'C	22'C	14'C	18'C	22'C
impatiens	*	*	*	*	*	*
antirrhinums**	8	7	3	4	3	*
geraniums	8	5	*	12	8	4
marigolds	*	*	*	*	*	*
petunias	6	3	*	3	*	*
salvias	*	*	*	*	*	*

* All crops produced a positive *Profit Margin.*
** Lower temperatures apply

[2]For a definition of overheads and costs of space see paragraph 2.1

- Geraniums, antirrhinums and petunias are particularly sensitive to increases in overhead charges, since they have a long growing period and hence a high space/time use. This suggests that where overhead charges are high it is more important to grow at high temperatures that reduce the cropping length.

5.3 Effects of Buying-in Plugs Viz Home Grown:

In this study, it is assumed that bought-in plugs and home grown plugs have the same growing on time, (see para 3.1.1). Using bought-in plugs therefore reduces *Profit Margin* compared with using home grown plugs. The costs are higher, but there is no countervailing advantage of a shorter growing period.

Where the growing period is short the impact of bought-in plug costs is relatively greater and the *Profit Margin* is reduced compared with home grown plugs. Hence, the reduction in *Profit Margin* through the use of bought-in plugs increases as temperature rises and the sowings become later. The key element is the shortening of the growing period under both of these conditions, since the difference between the actual cost of home grown and bought-in plugs is spread over fewer weeks and hence less space/time.

- The shorter the crop the bigger the impact on *Profit Margin* of increased plug costs.

It is recognised that where the use of more advanced bought-in plugs reduces the growing time, compared to home grown, then the additional costs of the bought-in plugs can be offset by savings in the cost of space/time, and opportunities of additional income from extra crops.

The cost differential between home grown and bought-in plugs can have a significance equal in size to that caused by a £0.50+ increase in overhead charge. For packs in particular it can be even higher later in the season. However, this needs to be set against the higher actual *Profit Margins* later in the season.

The following table indicates the first week in which a positive Profit Margin is achieved when bought-in plugs are used and an overhead charge of £1.50 is made.

Crop	Bought-in plugs:Pots			Bought-in plugs:Packs		
Overhead charge £1.50/sq.m/week	14'C	18'C	22'C	14'C	18'C	22'C
impatiens	7	3	*	7	4	*
antirrhinums**	12	12	9	10	10	9
geraniums	12	8	4	16	14	13
marigolds	9	6	6	12	13	10
petunias	10	5	2	8	4	*
salvias	*	*	*	*	*	*

* All crops produced a positive *Profit Margin*.
** Lower temperatures apply.

The difference between the crops is a function of the different growing times and the variation in the extra cost incurred through using bought-in plugs.

- On the basis of the assumptions used in this report, when overheads are high the use of bought-in plugs is very questionable for all but the very latest crops, which have a lower time/space use.

5.4 Effects of Varying Sale Price Levels:

5.4.1 Reduction in *Profit Margin* when sales prices are reduced by 10%.

Reducing the sale price has the same impact as increasing production costs. The same influences come to bear and the effects are greater with short duration crops.

In this study, when an overhead charge of £1.00 per square metre per week was used, all crops grown from home grown plugs except some early crops of geraniums and petunias at 14'C produced positive *Profit Margins* even after a 10% reduction in sale price.

- In general a 10% reduction in sale price is less significant than either a £0.50 increase in overheads or the use of bought-in plugs.

5.5 RANKING OF HUSBANDRY SYSTEMS BY PROFITABILITY:

The rankings give the grower an opportunity to assess which method of production is most suited to him, in order to produce a crop at a given time. Crops maturing at the same time are ranked according to their *Profit Margin*. The rankings hinge on the impact of the plug cost differential and the space/time used.

The crops could be grouped into three types:

i. Those where plug cost has a greater impact on *Profit Margin* than temperature i.e. the *Profit Margin* for the home grown plugs at the lower temperatures is higher than that for bought-in plugs even at higher temperatures: antirrhinums and marigolds .
ii. Those where temperature has a greater impact than plug cost: geraniums
iii. The last one includes impatiens, petunias and salvias where temperature is dominant at the higher two temperatures but not the lower.

- To increase the *Profit Margin* when using home grown plugs,for a particular sale period, raise the temperature for antirrhinums and marigolds, before buying plugs in. Do the reverse for geraniums, i.e. use bought-in plugs before lowering the temperature.

5.6 OVERALL PROFITABILITY OF SYSTEMS:

This is an attempt to compare the profitability of using a single husbandry system for a whole season as opposed the comparison of the profitability of individual batches (see para 2.1.4.). Large volumes have been used to show more clearly the relative differences between the systems.

5.6.1 Total Profitability of All Batches:

This first comparison of the effects of increasing temperature assumes that 10,000 pots or packs are started for each of the 18 weeks. The *Total Profit* calculated is the profit i.e. total revenue less total costs for the whole 180,000 units grown.

The absolute levels of *Total Profit* are not given, however the differences in *Total Profit* between temperatures for each crop are. For antirrhinums, the difference between growing at 10'C and 18'C is about £2000 for 180,000 pots. At the other extreme the difference for petunias between growing at 14'C and 22'C is £7000. Impatiens, geraniums, marigolds and salvias lie in between the other two.

The pattern is the same for packs with the exception that the figures are larger by a factor of about 10.

5.6.2 Profitability of Typical Production Pattern:

This comparison of the effects of increasing temperature is based on a more realistic production schedule for the total production of 100,000 pots or packs to meet a typical sales pattern. The production of 100,000 units is not common in commercial practice, however, this volume was chosen to clearly demonstrate the differences in *Profit Margin* between cropping systems. For lower volumes these values can be adjusted down proportionately.

In practice the early batches with longer growing periods are not used and the simulation concentrates on the later part of the season where scheduling differences are smaller. For the shorter crops, like impatiens, marigold and salvias, the overall effect is to reduce the *Total Profit* compared with those discussed above (5.6.1). For the longer crops, antirrhinums and geraniums the *Total Profit* for a typical production pattern actually increases, compared to production based on weekly sowings of 10000 units from week 1, as the longer less profitable crops are dropped. The effects of increasing temperature for all crops is to increase *Profit Margin* but to a lesser extent than in 5.6.1.

These actual levels cannot be disclosed in this report,but the relative profitability of the crops can be ranked in decreasing order as follows:

1	marigold	2	salvias
3	impatiens	4	petunias
6=	geraniums	6=	antirrhinums

In practical terms other management criteria may outweigh some of the smaller *Total Profits* differences calculated. This may be the case for pots but for packs the greater *Total Profit* differences calculated weigh heavily in favour of using the highest convenient temperature.

5.6.3 Space Requirements of Typical Production Pattern

Shortening the growing period for a crop does two things:

i. It increases the *Profit Margin* because of lower space/time costs.
ii. It releases space which has an opportunity value for the production of other crops. This potential benefit was not considered in the study.

However, if this space goes unused then the opportunity is lost and more importantly all of the costs accrue to the existing crops, which reduces their *Profit Margins*.

To demonstrate the commercial impact of shorter crops the total space requirements for the typical commercial production pattern have been compared. The savings in space requirements for the typical commercial production pattern show the following:

Saving of space/time as a % of the space used at the lowest temperature

Increasing temperature from:	*low to medium*	*low to high*
Antirrhinums, impatiens, marigolds and salvias	about 10%	about 25%
Geraniums and petunias	30%	50%.

- Apart from increasing the *Total Profit,* raising temperatures gives major opportunities to intensify cropping.

5.7 Comparison of Heating Costs

The cost of heating is an important but not a major cost to most bedding plant growers.

All growers know that increasing the temperature usually increases the cost of heating in a disproportionate manner. This is the case if the area heated and the length of time it is heated remains constant. If however the length of time the area is used is reduced, and no cost incurred for the unused time, then the effects on fuel costs are not so clear cut. Equally if the heating is needed later in the season when ambient temperatures are higher than the cost is further reduced.

When growing periods are reduced either by increasing the growing temperature or by sowing later, then the amount of space to be heated for a particular crop is reduced.

To illustrate this point for all crops, the heating costs are compared for the three temperature regimes. The absolute level of cost is not important but the relative differences are. For pots some of the differences are too small when the figures are rounded to thousands of pounds. That is why the heating for pots appears to be zero irrespective of temperature. For packs the heating costs are greater and show the increases more clearly.

- For antirrhinums, impatiens, marigolds and salvias heating cost for the space used rises with temperature.

- For geraniums and petunias, the cost of heating for the space used falls as the temperature rises. The reason for this is that for these two crops the reduction in growing time and the saving in time /space is so large that smaller quantities of fuel are used even at the higher temperatures.

- The comparable *Total Profits* indicate clearly the benefits to be gained from growing at higher temperatures.

5.8 Effects of Spacing on Profit Margin

For most crops, growing pot thick without spacing will still produce a good quality plant. However, for geraniums, in particluar, this may not always be the case. So the effect of three spacing regimes on the *Profit Margin* are compared, namely for geraniums;

i. pot thick until sale ii. pot thick then spaced iii. spaced out when first set down

In economic terms this means that the cost of space will be increased in proportion to the amount of extra space being used. As has been seen with the varying of levels of overheads this can have a major impact on the *Profit Margin* of crops and on the *Total Profit* of the system of production.

As has been shown in Appendix A2.7.4 at 18'C the first sowing of geraniums to make a *Profit Margin* at full spacing is week 8 for pots and week 5 for packs. The situation is much worse if bought-in plugs are used. Full spacing is a costly exercise and is of doubtful profitabilty for geraniums particularly in the early and middle part of the season. It may be acceptable if the level of overhead charge is low, but even then it may be better to substitute labour cost for space cost and follow a half rather than a full spacing regime.

Full spacing also obviously considerably increases the overall space use and so reduces the opportunity for extra cropping.

- Full spacing is a costly exercise since it reduces *Profit Margin* and reduces the opportunity for other cropping, but this must be considered in view of any potential loss of plant quality.

Acknowledgements

We wish to thank a large number of growers who provided both financial and physical data on which to base this report. Regretably, we cannot name any individuals, since the data is confidential.

APPENDIX 1.

A1.0 ANTIRRHINUMS

A1.1 EFFECTS OF TEMPERATURE

A1.1.1 Effects of Changing Sowing Dates Within Each Temperature Regime on the Duration of Production

Antirrhinums were grown at the lower temperatures of 10'C, 14'C and 18'C. Growing times are generally longer than other crops and this is reflected in the results

Home Grown Plugs		*Growing Period weeks (rounded)*		
		10'C	*14'C*	*18'C*
Sowing week	1	16	15	13
	9	12	11	10
	18	9	9	8

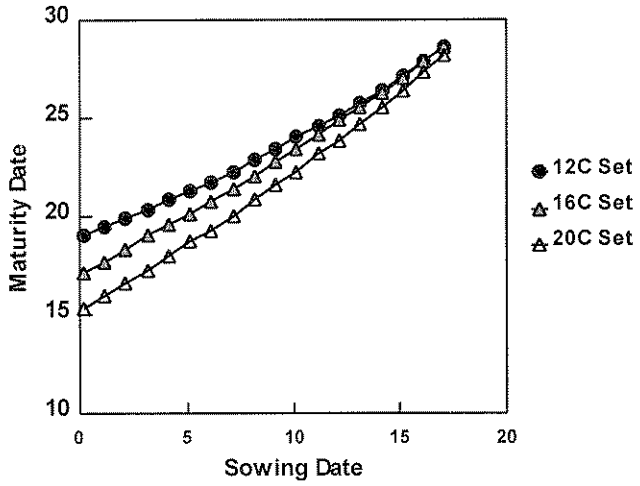


Figure A1.1.1 The sowing date schedules for antirrhinums grown at 3 different temperatures.

	Plugs	*Growing Period as % of wk1*			*Temperature as % of 10'C*		
		10'C	*14'C*	*18'C*	*10'C*	*14'C*	*18'C*
Sowing week	1	100	100	100	100	94	81
	9	75	73	77	100	92	83
	18	56	60	62	100	100	89

The reduction in the growing time early in the season, resulting from higher temperatures, almost disappeared at the end of the season. Overall though, sowing later in the season has a much greater effect than the increase in temperature.

A1.1.2 Comparison of the *Profit Margin* for the Different Sowing Dates within each Temperature Regime

The table below shows the differences in *Profit Margin* of antirrhinums grown at 10', 14' or 18'C, in either pots or packs and with different sowing dates.

Home Grown Plugs		*Pots*			*Packs*		
		Profit margin difference			*Profit margin difference*		
		10'C	*14'C*	*18'C*	*10'C*	*14'C*	*18'C*
Sowing week	1	0	0	0	0	0	0
	9	24	28	27	26	31	30
	18	52	50	55	58	56	63

With antirrhinums the progressive increase in *Profit Margin* as the season progresses is similar for all temperatures. There is no reduction in *Profit Margin* late in the season as seen in impatiens.

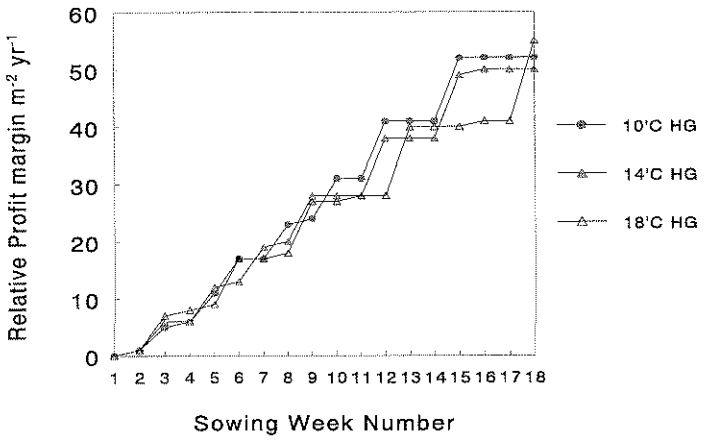


Figure A1.1.2 The relationship between sowing week number, temperature and *Profit Margin* for antirrhinums pots from home grown plugs, assuming and overhead charge of £1.00 per square metre per week, data normalised to batch 1 at all temperatures.

A1.1.3 Comparison of Relative *Profit Margins* Between Temperature Regimes by Sowing Date.

The changes in relative profitability of each sowing date over the three temperature regimes during the growing season were compared. The data were normalised for each sowing to the *Profit Margin* at 10'C.

Home Grown Plugs		*Pots*			*Packs*		
		PM difference			*PM difference*		
		10'C	*14'C*	*14'C*	*10'C*	*14'C*	*18'C*
Sowing week	1	0	2	10	0	2	11
	9	0	6	13	0	7	15
	18	0	0	13	0	0	15

Although it is true that the higher the temperature the higher the *Profit Margin.* This is not as great for antirrhinums as for impatiens. Nor is there the big difference between the beginning of the season and the end.

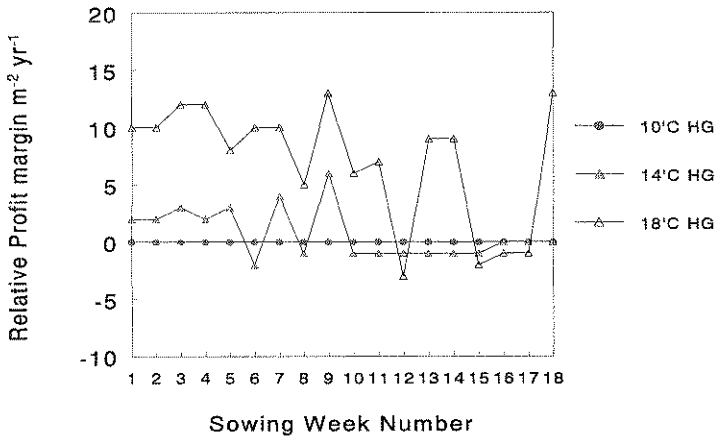


Figure A1.1.3. The effects of temperature and sowing week on *Profit Margin* for pot antirrhinums from home grown plugs, at an overhead charge of £1.00 per square metre per week. Data are normalised with the 10'C Profit Margin set at "0" in each week.

Although antirrhinums were responsive to temperature in their growing stage the changes in *Profit Margin* are more muted than for impatiens. This may be a mathematical effect of the longer growth periods when multiplied by an overhead charge, which may be damping changes. Equally the lower temperatures used at the top end namely 18'C rather than 22'C may also have had an effect.

A1.2 Effects of Varying The Level of Overhead Costs

As was demonstrated with the impatiens, varying the overhead charge from the standard of £1.00 per square metre week by plus or minus £0.50 produces a constant relative *Profit Margin* change of +- £26.00.

Of more significance for antirrhinums are the actual levels of *Profit Margin* calculated.

Pots: At both £1.00 and £0.50 all batches at all temperatures made a *Profit Margin* when grown from home grown plugs. At £1.50 some of the early crops made a loss. For example batches using home grown plugs made losses in sowings up to weeks 8 at 10'C, week A1 at 14'C and week 3 at 18'C. The losses for bought-in plugs are discussed later.

Packs: A similar but less marked pattern exists with packs. At £1.50 batches 1-4 are loss making at 10'C, batches 1 and 2 at 14'C, but all were profitable at 18'C.

The impact of the longer growing periods is exaggerated when a higher overhead charge is levied. Some early crops are not profitable. The differential influence between pots and packs may be a reflection of the cost of home grown plugs in relation to the respective sale price.

A1.3 Effects of Buying-in Plugs viz Home Grown

The table below and Figures A1.3.1a and b show the differences in *Profit Margin* for pots and packs produced from home grown or bought-in plugs when grown at one of three different temperatures.

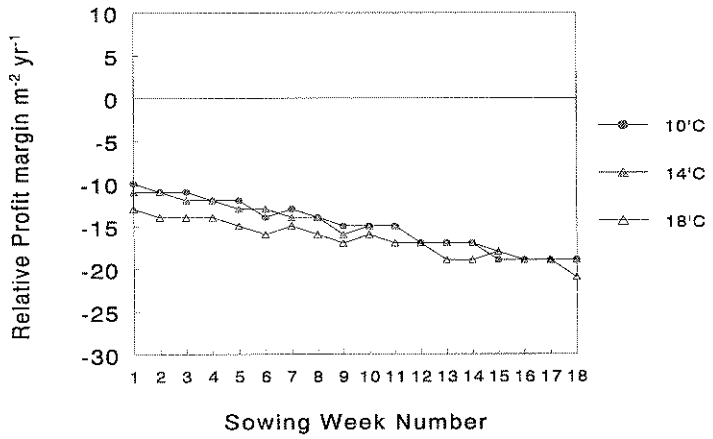
Comparison of difference in Profit Margin between plug sources: *Reduction in Profit Margin when Bought-in Plugs are used*

		Pots			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		10'C	*14'C*	*18'C*	*10'C*	*14'C*	*18'C*
Sowing week	1	-10	-11	-13	-18	-18	-21
	9	-15	-16	-17	-23	-25	-27
	18	-19	-19	-21	-30	-31	-34

The impact of using bought-in plugs is still to reduce profitability but the effect is marginally less than in impatiens. Again the impact of bought-in plugs is greater with packs.

The impact of increasing overhead charges has been discussed the previous paragraph . With this crop, even with £1.00 per square metre per week, the first two batches using bought-in plugs at 10'C make a loss whilst the first batch at 14'C only breaks even.

Pots



Packs

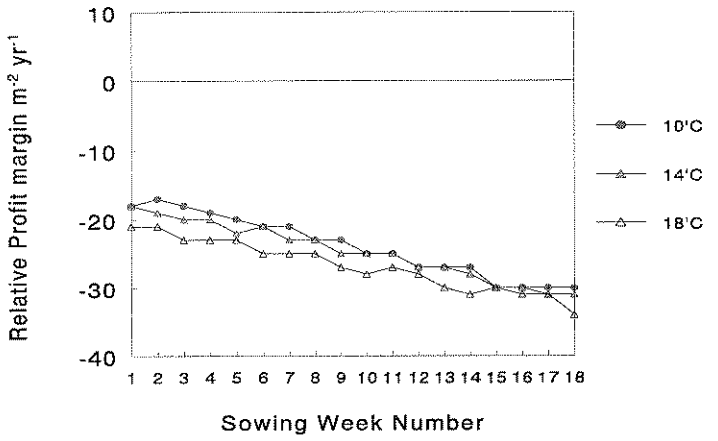


Figure A1.3.1 Reduction in *Profit Margin* when bought-in plugs are used for pots (A1.3.1a) and packs (A1.3.1b) antirrhinums plugs, at an overhead charge of £1.00 per square metre per week. Data for crops grown from bought-in plugs normalised with the *Profit Margin* for comparable crops from home grown plugs set at "0" in each week.

A1.4 EFFECTS OF VARYING PRICE LEVELS:

A1.4.1 Actual Difference in Profit Margin between Standard Price and 10% Reduction

The impact of reducing prices has also been assessed comparing two levels of price, data are normalised to the *Profit Margin* at the standard price.

Home Grown Plugs	*Pots*			*Packs*		
	Profit Margin difference			*Profit Margin difference*		
	10'C	*14'C*	*18'C*	*10'C*	*14'C*	*18'C*
Sowing Week 1	- 8	- 8	-10	-9	-9	-11
9	- 11	-12	-13	-12	-13	-14
18	- 14	-15	-16	-16	-17	-19

For both pots and packs the reduction in *Profit Margin,* due to price, increases as the temperature increases and the season progresses. However this needs to be set against the higher *Profit Margin* later in the season illustrated in paragraph A1.1.2

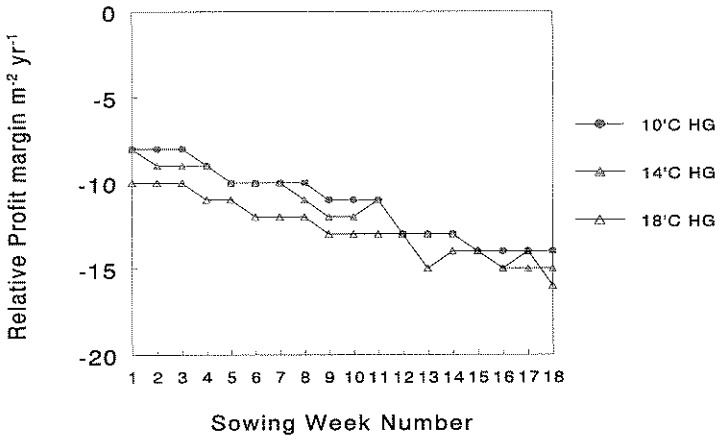


Figure A1.4.1 The effects of a 10% reduction in price of pot antirrhinums expressed as actual differences compared with the *Profit Margin* at the full price.

A1.5 Ranking of Husbandry Systems by Profitability

In order to assess any changes in the relative profitability of the systems between the sales week *Profit Margins* were ranked, as for the impatiens (4.5).

Maturity Week	*Temp. 'C*	*Propagating System*	*Sowing Week*	*No Weeks Growing*	*Relative PM Value.*	*Ranking*
17	18	HG	3	12	20	1
	18	HG	2	13	14	1
	18	Buy	3	12	6	3
	18	Buy	2	13	0	3
20	18	HG	7	11	37	1
	14	HG	5	13	24	2
	18	Buy	7	11	22	3
	14	HG	4	14	18	2
	10	HG	3	15	15	4
	10	HG	2	16	11	4
	14	Buy	5	13	11	5
	14	Buy	4	14	6	5
	10	Buy	3	15	4	6
	10	Buy	2	16	0	6
23	18	HG	11	10	29	1
	10	HG	10	11	22	4
	14	HG	10	11	21	2
	10	HG	9	12	15	4
	18	Buy	11	10	12	3
	10	Buy	10	11	7	6
	14	Buy	10	11	6	5
	10	Buy	9	12	0	6

Only by growing at 18'C was a saleable crop achieved by week 17. There is a clear preference for the use of home grown plugs at both weeks 20 and 23. In week 20, the profitability of bought-in plugs grown at 18'C is similar to home grown plugs at 14'C. The home grown plugs have a clearer advantage in antirrhinum production than with impatiens.

The pattern is the same for packs with the exception that the range of *Profit Margin* is greater between the best and the poorest in each sales week.

A1.6 Overall Profitability of Systems

A1.6.1 Total Profitability of All Batches:

The *Total Profit* was determined for 10,000 pots or packs produced for each batch for 18 weeks.

Differences in Total Profit (£000's) compared with 10'C (home grown)

	10'C		*14'C*		*18'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-7	0	-7	2	-5
Packs	0	-81	1	-80	12	-69

The differences for antirrhinums are similar to Impatiens for pots and packs at both 14' and 18'C.

A1.6.2. Profitability of Typical Production Pattern:

The production of 100,000 units was examined for a typical production pattern at different temperatures.

Differences in Total Profit (£000's) compared with 10'C (home grown)

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-3	1	-2	4	0
Packs	0	-45	7	-38	24	-21

The differences between the actual *Total Profit* values for the pots using home grown cuttings over the 3 temperatures is relatively small. The bigger difference is between home grown and bought-in.

The overall differences are very similar to those produced by the impatiens crops when the same temperatures are compared for each crop.

A1.6.3 Space Requirements of Typical Production Pattern.

The space requirement for pots are shown in Figure A1.6.3. At the beginning of the season a rise in temperature of 4'C results in a shortening of the growing period by 1 or two weeks. This narrows to 1 weeks in the middle of the season.

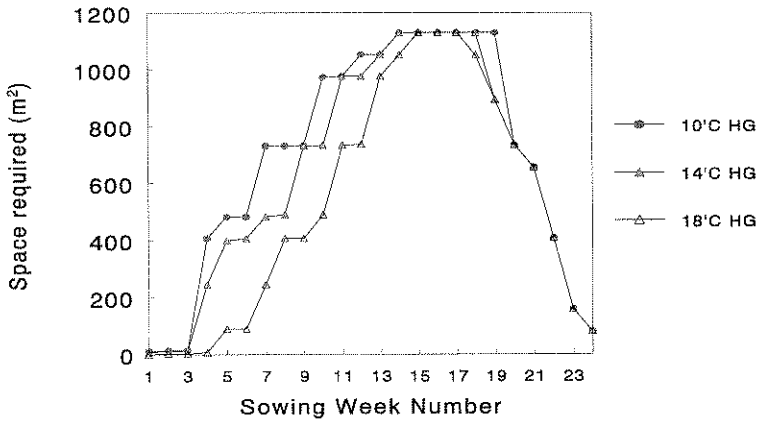


Figure A1.6.3 The area required for a typical production pattern of 100,000 pots.

The graph shows that the reduction in space requirement in the first half of the season is more clear cut between 14'C and 18'C than between 10 and 14'C.

Space Requirements of Typical Production Pattern as a Percentage of 10'C

Temperature	*10'C*	*14'C*	*18'C*
Pots/ Packs	100%	92%	77%

These figures also demonstrate the increased saving in space between 14' and 18'C. Overall the saving are smaller than those seen for impatiens.

A1.7 Comparison of Heating Costs

Differences in Heating Costs and Total Profit (000's) compared with 14'C

Home Grown Plugs	*10'C*	*14'C*	*18'C*
Pots			
Increase in Heating Costs (£000)	0	0	0
Difference in Total Profit (£000)	0	1	4
Packs			
Increase in Heating Costs (£000)	0	6	13
Difference in Total Profit (£000)	0	7	24

The above figures show the relationship between changes in heating costs for the three regimes and the *Total Profit* which is of course after the deduction of heating costs.

APPENDIX 2

A2.0 GERANIUMS

A2.1 EFFECTS OF TEMPERATURE:

A2.1.1 Effects of Changing Sowing Dates Within Each Temperature Regime on the Duration of Production

Geraniums were grown at 14'C, 18'C and 22'C.

Home Grown Plugs		*Growing Period weeks (rounded)*		
		14'C	*18'C*	*22'C*
Sowing week	1	16	12	10
	9	11	9	7
	18	7	7	6

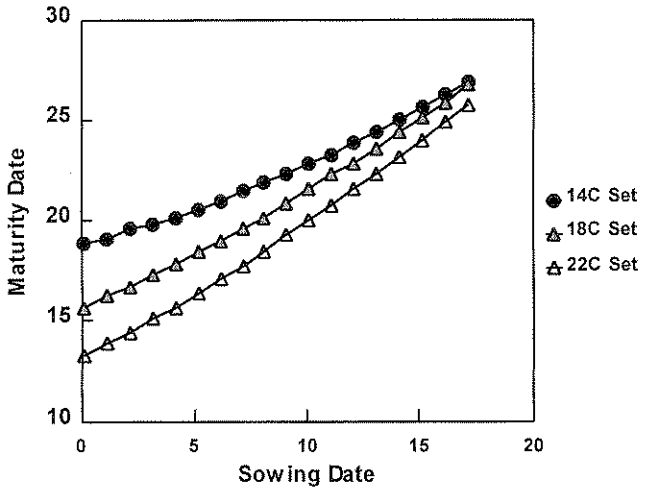


Figure A2.1.1 The sowing date (weeks) schedules for geraniums grown at 3 different temperatures

Home Grown Plugs		*Growing Period as % wk1*			*Temperature as % 14'C*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	100	100	100	100	75	63
	9	69	75	70	100	82	64
	18	44	58	60	100	100	86

The growing time for geraniums falls sharply as the season progresses from 16 to 7 weeks, when grown at 14'C. Equally the crop seems to be very temperature responsive with a difference in growing time even in the middle of the season of 4 weeks when comparing growing at 14'C and 22'C. Later in the season the effect of temperature all but disappears.

A2.1.2 Comparison of the *Profit Margin* for the Different Sowing dates within each Temperature Regime.

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	0	0	0	0	0
	9	28	29	43	25	25	37
	18	77	60	68	66	52	59

The crop responds very well to the improving growing conditions as the season progresses. The increase in profitability for all temperatures and containers is very marked. It is significantly higher than even impatiens.

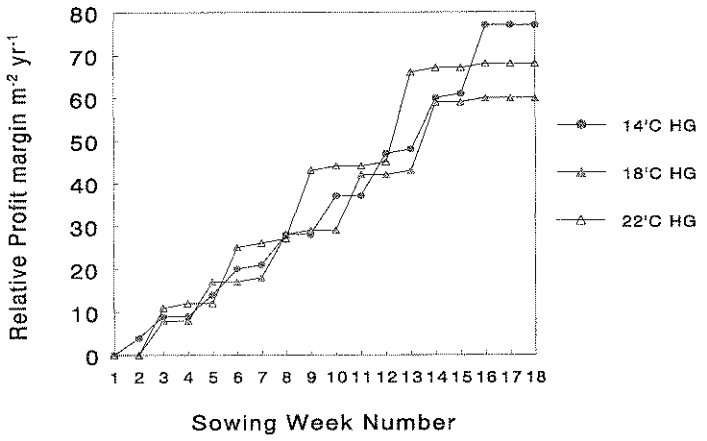


Figure A2.1.2 The relationship between sowing week number, temperature and *Profit Margin* for geraniums pots from home grown plugs, assuming an overhead charge of £1.00 per square metre per week, data normalised to batch 1 as "0" at all temperatures.

A.2.1.3 Comparison of Relative Profit Margins between Temperature Regimes by Sowing Date

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	16	28	0	13	23
	9	0	17	43	0	13	35
	18	0	-1	19	0	-1	16

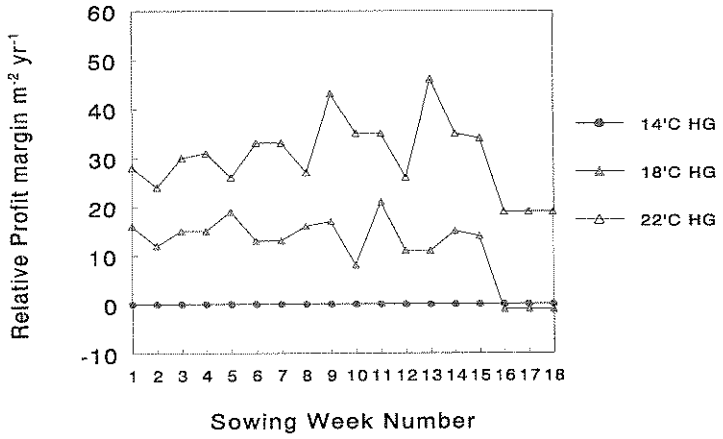


Figure A2.1.3. The effects of temperature and sowing week on *Profit Margin* for pot geraniums from home grown plugs, at an overhead charge of £1.00 per square metre per week. Data are normalised with the 14'C *Profit Margin* set at "0" in each week.

These results demonstrate a rather curious pattern. Batches 1 and 9 for all temperatures follow previous patterns with the *Profit Margin* rising with temperature. At the end of the season there is no improvement from increasing temperature from 14 to 18'C but a significant one to 22'C. This applies to both pots and packs.

General Comments: Geraniums appear to be very responsive to temperature and light at the beginning of the season and the *Profit Margins* reflect this. Later in the season temperature is not a limiting factor and with adequate light only the 22'C regime gives a response in terms of *Profit Margins*

A2.2 Effects of Varying the Level of Overhead Costs:

Batch 1 at 14'C is barely profitable at an overhead charge of £1.00. The profitability falls markedly when this charge is increased to £1.50. For pots the first 7 batches at 14'C and the first 4 at 18'C are not profitable. The situation is even worse with packs where a *Profit Margin* is only achieved in batch 12 at 14'C and batch 8 at 18'C. Even the first four batches at 22'C failed to achieve a *Profit Margin*.

The economics of this crop appear to be very sensitive to high overhead cost levels.

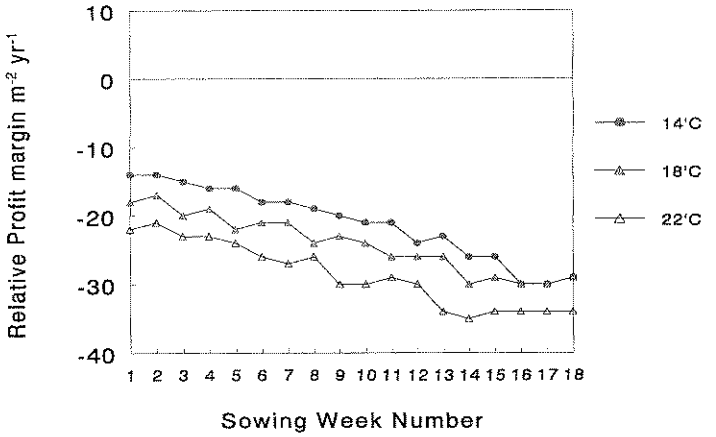
A2.3 Effects of Buying in Plugs Viz Home Grown:

Comparison of difference in Profit Margin between plug sources: Reduction in Profit Margin when bought-in plugs are used.

		Pots			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	-8	-11	-13	-14	-18	-22
	9	-11	-15	-18	-20	-23	-30
	18	-18	-18	-18	-29	-29	-34

The profitability of growing with home grown plugs is greater than that with bought-in. Equally this difference widens the later it is in the season and warmer the regime.

Pots



Packs

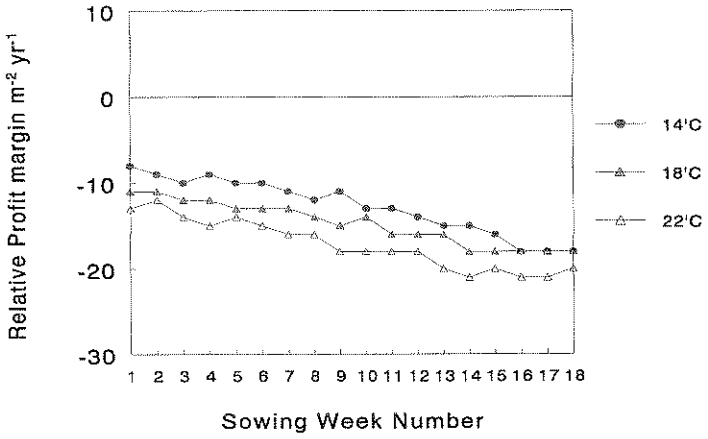


Figure A2.3.1. The reduction in *Profit Margin* when bought-in plugs are used for pot (A2.3.1a) and pack (A2.3.1b) geraniums, at an overhead charge of £1.00 per square metre per week. Data for crops grown from bought-in plugs normalised with the *Profit Margin* for comparable crops grown from home grown plugs set at "0" in each week.

A2.4 Effects of Varying Price Levels:

A2.4.1 Actual Difference in *Profit Margin* between Standard Price and 10% Reduction

Home Grown Plugs	*Pots*			*Packs*		
	Profit Margin difference			*Profit Margin difference*		
	14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing Week 1	(-11)	(-15)	(-18)	(-11)	(-15)	(-18)
9	-15	-20	-25	-16	-20	-25
18	-25	-24	-29	-25	-25	-29

The effect of a price reduction is greater the later the batch is in the season and the higher the temperature. Of greater significance than the relativities are the actual levels of *Profit Margin* or loss. For pots only batches 1 to 4 at 14'C showed losses denoted by brackets in the table above. The situation is considerably worse with the packs where batches 1 to 7, 1 to 4 and 1 to 2 respectively of 14', 18' and 22'C produced losses. When the price reduction applies to packs grown from bought-in plugs then the last few weeks show a *Profit Margin*.

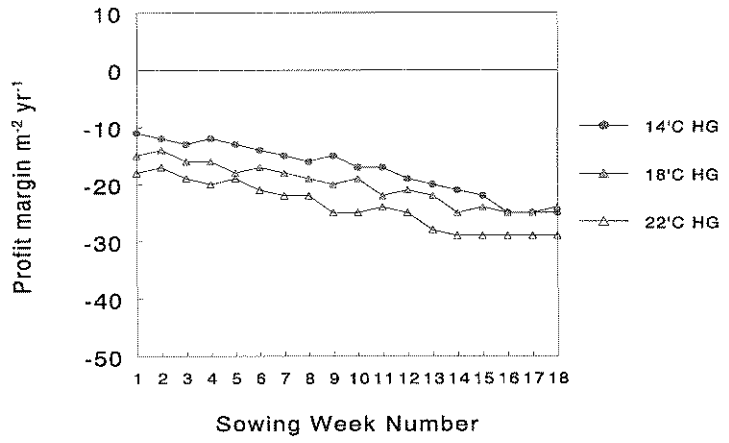


Figure A2.4.1 The effects of a 10% reduction in price of pot geraniums expressed as actual differences compared with the *relative Profit Margin* at the full price.

A2.5 Ranking of Husbandry Systems by Profitability:

Pot Production

Maturity Week	Temp. 'C	Propagating System	Sowing Week	No Weeks Growing	Relative PM Value.	Ranking
17	22	HG	7	8	42	1
	22	Buy	7	8	26	2
	18	HG	5	10	21	3
	18	HG	4	11	12	3
	18	Buy	5	10	(8)	4
	18	Buy	4	11	(0)	4
20	22	HG	11	7	72	1
	22	Buy	11	7	54	2
	18	HG	9	9	45	3
	18	Buy	9	9	30	4
	14	HG	6	12	20	5
	14	HG	5	13	14	5
	14	Buy	6	12	(10)	6
	14	HG	4	14	(9)	5
	14	Buy	5	13	(4)	6
	14	Buy	4	14	0	6
23	22	HG	15	6	71	1
	18	HG	14	7	51	**3**
	22	Buy	15	6	51	**2**
	18	HG	13	8	35	3
	18	Buy	14	7	33	4
	14	HG	12	9	23	5
	18	Buy	13	8	19	4
	14	HG	11	10	13	5
	14	Buy	12	9	9	6
	14	Buy	11	10	0	6

Note that no batch grown at 14'C is ready by week 17 and also that there are two batches grown at 18'C ready in this week.

The pattern for geraniums is similar for impatiens, namely that in the earlier sale periods the impact of temperature outways the cost increase of bought-in plugs. This is less marked in week 23. The pattern for packs is virtually the same as for pots. The noticeable exception being that for week 17 the two lowest batches, 18'C Buy, are in fact unprofitable. The same applies in week 20 where the three 14'C Buy are unprofitable.

A2.6 Overall Profitability of Systems:

A2.6.1 Total Profitability of All Batches:

Differences in Total Profit (£000's) compared with 14'C (home grown)

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-5	3	-2	6	1
Packs	0	(-62)*	22	-40	41	-21

Each unit difference between indices is £1000. This shows that there is a difference of £6000 in *Total Profit* between growing 180,000 pots at 22 rather than 14'C. There is a similar advantage between using home grown compared with bought plugs. The price difference for home grown and bought-in plugs was closer for geraniums than other crops. The pattern for packs is similar but the differences are in reality much greater.

*The total for 14'C bought-in plugs in fact represents a loss overall.

A2.6.2 Profitability of Typical Production Pattern:

Differences in Total Profit (£000's) compared with 10'C (home grown)

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-2	5	2	7	5
Packs	0	(-34)*	34	0	52	18

The removal of the earlier batches in the pot production has had a major impact on the relative profitabilities of the production patterns. The removal of the earlier and so longer production batches has improved the overall profitability to a marked extent.

There is a very much more marked increase in *Total Profit* for both home grown and bought-in plugs than in A2.6.1.

These improvements are shown even more clearly in the pack production. Although the *Total Profit* at 14'C is actually loss making those at 18'C and 22'C either breakeven or exceed the *Total Profit* for 14'C home grown plugs.

A2.6.3 Space Requirements of Typical Production Pattern

Figure A2.6.3 shows the weekly space requirements for the typical production pattern of 100,000 pots. The substantial effect of both increased temperature and improved growing

conditions later in the season are clearly illustrated in the graph. These differences can be quantified by comparing the total requirements of the three temperature regimes.

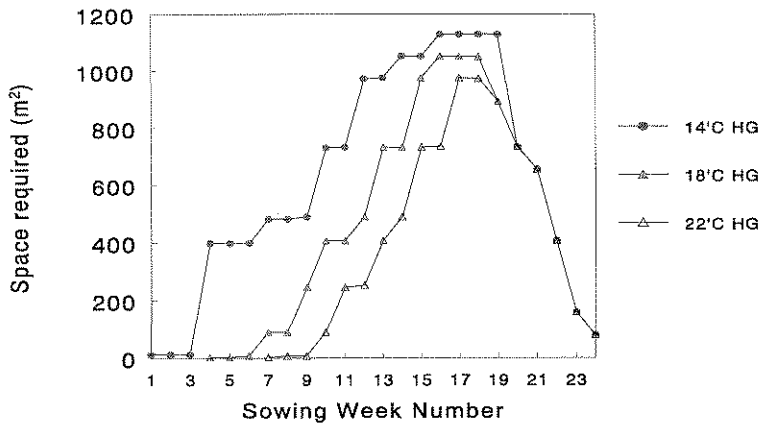


Figure A2.6.3 The area required for a typical production pattern for 100,000 pots.

Space Requirements of Typical Production Pattern as a Percentage of 14 'C

Temperature	*14'C*	*18'C*	*22'C*
Pots/Packs	100%	70%	53%

The increase in temperature from 14'C to 22'C almost halves the overall space requirement for geraniums. This in turn has a big impact on the *Total Profit* as the heavy burden of the cost of space decreases with the shortening of the crop.

A2.7 Comparison of Heating Costs

Differences in heating costs and Total Profit (000's) compared with 14'C

Temperature	*14'C*	*18'C*	*22'C*
Pots			
Increase in Heating Costs (£000)	0	-1	-1
Difference in Total Profit (£000)	0	5	7
Packs			
Increase in Heating Costs (£000)	0	0	0
Difference in Total Profit (£000)	0	34	18

Heating costs for this crop are behaving in an unusual manner. They are going down whilst the growing temperature is increasing. The fuels costs reflect the actual fuel used to heat the space required to the set point temperature. The reduction in space/time requirement for geraniums as the temperature rise is sufficient to more than compensate for the extra heating cost. In other words the area required for heating is so much smaller at 22'C it actually costs less to heat than the area used for production at 14'C.

The above saving in fuel only occurs if the crop is not spaced out during the growing period. Most geraniums will be spaced out at some stage and the impact of this is discussed in the following paragraph.

A2.8 EFFECTS OF SPACING ON *PROFIT MARGIN*

A2.8.1 Comparison of Spacing Systems

The geranium crop generally needs more space than other crops so that individual plants can reach the required quality standard. This can either achieved by growing the crop pot thick until part way through the growing cycle and then spacing them out or the alternative is to put them out after transplanting in their final spaced position.

Half or Intermediate Spacing:

i Pots are assumed to be grown in 15 pot growing trays until half way through the growing period. Then 6 pots were removed from each tray.

ii Packs are grown pack thick again until half way through the growing period, when they are spaced out to give about one third more space. This equates to about a 4 cm gap between trays in both directions.

The spacing for pots increases by about 40% whilst for packs it is about 34%.

Full Spacing:

The same spacing out layouts were used but the containers were placed into their final positions after transplanting.

A2.7.2 Comparisons of Changing Sowing Dates Within Each Spacing Regime:

Home Grown Plugs		*Pots 18'C*			*Packs 18'C*		
		Profit Margin difference			*Profit Margin difference*		
Spacing		*None*	*Half*	*Full*	*None*	*Half*	*Full*
Sowing Week	1	0	0	(0)*	0	0	(0)*
	9	29	25	19	25	22	(16)*
	18	60	54	40	52	44	34

* denotes an overall loss

The impact of both spacing systems follows the pattern for the none spaced regime. As the season progresses the *Profit Margin* increases reflecting the shorter growing period. As the amount, and so the cost of space increases from none to half to full then the *Profit Margin* falls.

A2.7.3 Comparison of Spacing Regime by Sowing Date:

Home Grown Plugs		*Pots 18'C*			*Packs 18'C*		
		Profit Margin difference			*Profit Margin difference*		
Spacing		*None*	*Half*	*Full*	*None*	*Half*	*Full*
Sowing Week	1	0	-14	(-31)	0	(-10)	(-16)
	9	0	-18	-41	0	-14	(-21)
	18	0	-20	-51	0	-18	-27

This table shows the impact of spacing for each sowing date. The loss of *Profit Margin* increases as the season progresses. This is more marked for the pots than the packs. Once again the half spacing holds an intermediate value between the none and full spacing for the pots but is closer to the full spacing for the packs.

A2.7.4 Actual Levels of *Profit Margin*

When the cost of space was increased per square metre, see para A2.2, a significant number of batches failed to achieve a positive *Profit Margin*. The same applies to the increases in use of space by spacing. The following table shows the first sowing week for which a positive *Profit Margin* was calculated.

	Pots 18'C			*Packs 18'C*		
	Positive Profit Margin			*Positive Profit Margin*		
Spacing/	*None*	*Half*	*Full*	*None*	*Half*	*Full*
Week number						
Home Grown Plugs	1	1	8	1	3	5
Bought-in Plugs	1	4	11	6	11	14

These figures clearly demonstrate the sensitivity of this crop to increases in costs of production be they direct costs eg plant costs or indirect space costs.

APPENDIX 3

A3.0 MARIGOLDS

A3.1 EFFECTS OF TEMPERATURE:

A3.1.1 Effect of Changing Sowing Dates Within Each Temperature Regime on the Duration of Production

Marigolds were grown at 14'C, 18'C and 22'C.

Home Grown Plugs		*Growing Period weeks (rounded)*		
		14'C	*18'C*	*22'C*
Sowing week	1	13	11	10
	9	9	8	8
	18	7	7	6

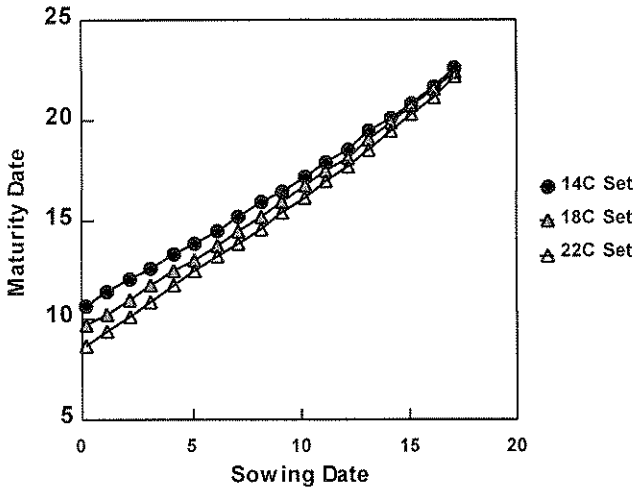


Figure 8.1.1 The sowing date schedules for marigolds grown at 3 different temperatures

Home Grown Plugs		*Growing Period as %of wk1*			*Temperature as % of 14'C*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	100	100	100	100	85	77
	9	69	73	80	100	89	89
	18	54	64	60	100	100	86

The impact of sowing date is much greater than the effect of temperature. The reduction in growing time through increased temperature reduces as the season progresses.

A3.1.2 Comparison of the *Profit Margin* for the Different Sowing dates within each Temperature Regime.

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	0	0	0	0	0
	9	57	60	47	63	68	53
	18	117	97	135	130	109	150

When compared with other crops there is a very marked increase in the marigold *Profit Margin* with both later sowings and with increases in temperatures. Once again it needs to be remembered that these figures reflect the differences in not the actual level of *Profit Margin*.

The lower *Profit Margin* at 18'C for week 18 results not from parity between actual *Profit Margins* for14' and 18'C in week 18, but the differential between them in week1.

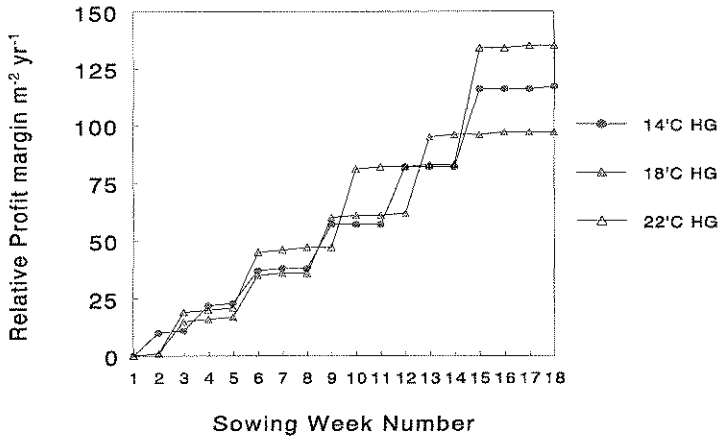


Figure A3.1.2. The relationship between sowing week number, temperature and *Profit Margin* for pot marigolds from home grown plugs, assuming an overhead charge of £1.00 per square metre per week, data normalised to batch 1 as "0" at all temperatures.

A3.1.3 Comparison of Relative *Profit Margin* between Temperature Regimes by Sowing Date

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	18	29	0	20	33
	9	0	21	19	0	25	23
	18	0	-2	47	0	-1	53

These results show the same curious pattern exhibited by the geraniums. The actual *Profit Margins* show a steady increase with temperature early in the season. In the middle it becomes less obvious whilst at the end the *Profit Margin* for 14'C and 18'C are very similar.

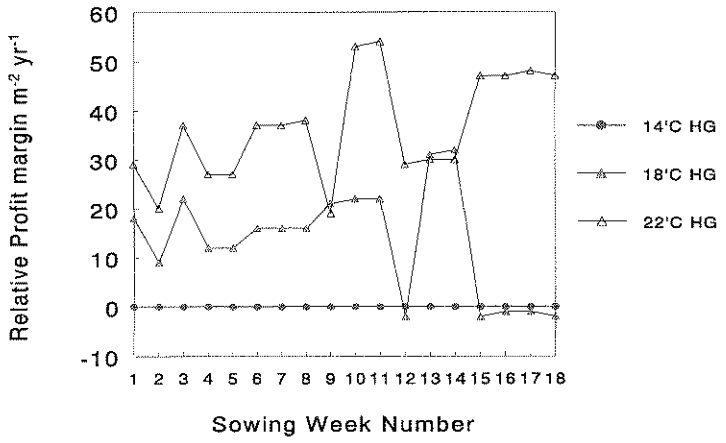


Figure A3.1.3. The effects of temperature and sowing week on *Profit Margin* for pot marigolds from home grown plugs, at an overhead charge of £1.00 per square metre per week, data are normalised with the 14'C *Profit Margin* set at "0" in each week.

General Comments: Marigolds appear to be similar to geraniums in their response to temperature and light and the *Profit Margins* reflect this.

A3.2 Effects of Varying the Level of Overhead Costs:

The impact of higher levels of overhead charge has less effect on marigolds compared with other crops. Even at £1.50 per square metre week there is still a *Profit Margin* for both pots and packs produced from home grown plugs.

A3.3 Effects of Buying in Plugs Viz Home Grown:

Comparison of difference in Profit Margin between plug sources: Reduction in Profit Margin when bought-in plugs are used

		Pots			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	-37	-46	-51	-61	-75	-84
	9	-59	-67	-68	-96	-111	-111
	18	-81	-81	-101	-132	-133	-164

The difference in price between home grown and bought-in marigold plugs results a very significant difference in *Profit Margins*. Bigger than those for other crops. Some of the early batches for pots grown from bought-in plugs show a negative *Profit Margin* even with overheads at £1.00 per square metre per week. At £1.50 the results are much poorer.

Pots

Packs

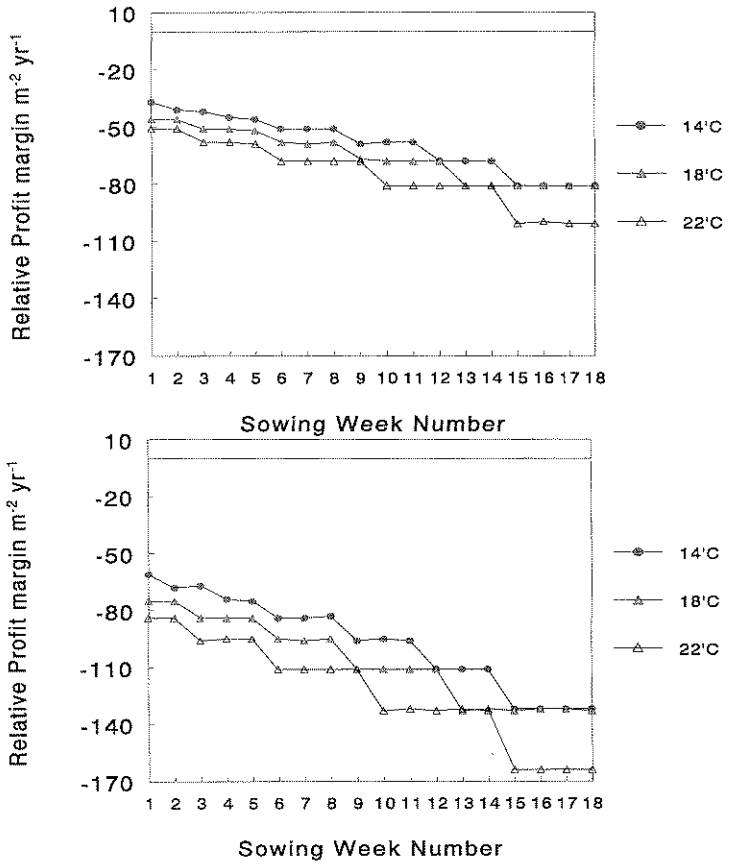


Figure A3.3.1 Reduction in *Profit Margin* when bought-in plugs are used for pots (A1.3.1a) and packs (A1.3.1b) marigolds plugs, at an overhead charge of £1.00 per square metre per week. Data for crops grown from bought-in plugs normalised with the *Profit Margin* for comparable crops from home grown plugs set at "0" in each week.

A3.4 Effects of Varying Price Levels:

A3.4.1 Actual Difference in *Profit Margin* Between Standard Price and 10% Reduction

Home Grown Plugs	*Pots*			*Packs*		
	Profit Margin difference			*Profit Margin difference*		
	14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing Week 1	-15	-19	-22	-14	-16	-18
9	-25	-28	-28	-21	-25	-25
18	-35	-34	-43	-29	-30	-36

A price reduction of 10% has a greater impact on the *Profit Margin* of marigolds than other crops. From a practical point of view it means that there is little or no *Profit Margin* for packs grown from bought-in plugs until just over half way through the season. Even for pots the same pattern holds for 14'C and improves but slowly for the other two temperatures.

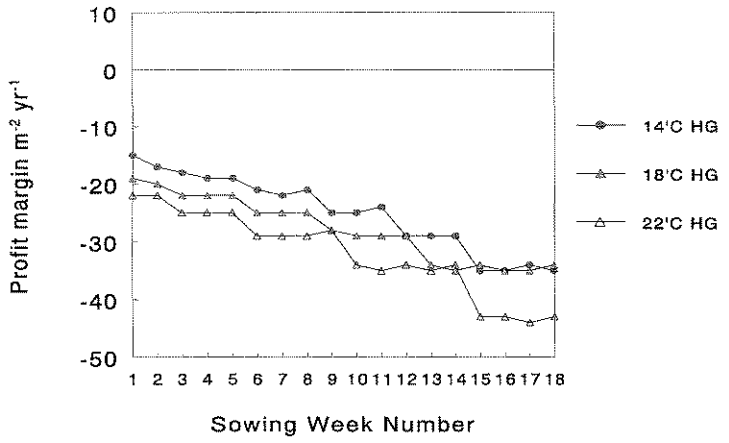


Figure A3.4.1. The effects of a 10% reduction in price of pot marigolds expressed as actual differences compared with the *relative Profit Margin* at the full price.

A3.5 RANKING OF HUSBANDRY SYSTEMS BY PROFITABILITY:

Pot Production

Maturity Week	Temp. 'C	Propagating System	Sowing Week	No Weeks Growing	Relative PM Value.	Ranking
17	22	HG	11	4	124	1
	18	HG	10	5	92	2
	14	HG	9	6	70	3
	14	HG	8	7	51	3
	22	Buy	11	4	43	4
	18	Buy	10	5	24	5
	14	Buy	9	6	11	6
	14	Buy	8	7	0	6
20	22	HG	15	3	149	1
	18	HG	14	4	100	2
	22	HG	14	4	98	1
	14	HG	13	5	68	3
	22	Buy	15	3	48	4
	18	Buy	14	4	19	5
	22	Buy	14	4	17	4
	14	Buy	13	5	0	6
23	22	HG	18	3	130	1
	14	HG	17	4	82	3
	18	HG	17	4	81	2
	22	Buy	18	3	29	4
	14	Buy	17	4	1	6
	18	Buy	17	4	0	5

The impact of the price differential between home grown and bought-in plugs is clearly shown above. It clearly outweighs the increased cost of heating. This is unusual in relation to other crops.

Another feature is the very large difference between the best and worst *Profit Margin* for sale in any one week. However when only home grown crops alone are compared then the differences are not so great but still larger than other crops.

A3.6 OVERALL PROFITABILITY OF SYSTEMS:

A3.6.1 Total Profitability of All Batches:

Differences in Total Profit (£000's)

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-16	1	-15	3	-14
Packs	0	-194	9	-185	19	-175

The difference *in total Profit* between growing 18 batches of 1000 pots at 14'C and 22'C is only about £3000. For packs it is understandably larger at about £19,000.

The differential between the cost of home grown and bought-in plugs is sharply demonstrated. The impact reduces as the temperatures increase and growing periods shorten.

A3.6.2 Profitability of Typical Production Pattern:

Differences in Total Profit Margin (£000's)

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-9	1	-8	2	-7
Packs	0	-108	5	-103	12	-96

The more realistic cropping pattern with the much reduced early production has a muting effect on the differences.

A3.6.3 Space Requirements of Typical Production Pattern

The difference between the space requirements for the temperature regimes are similar to those for impatiens (see Fig A3.6.1) Both are relatively short duration crops.

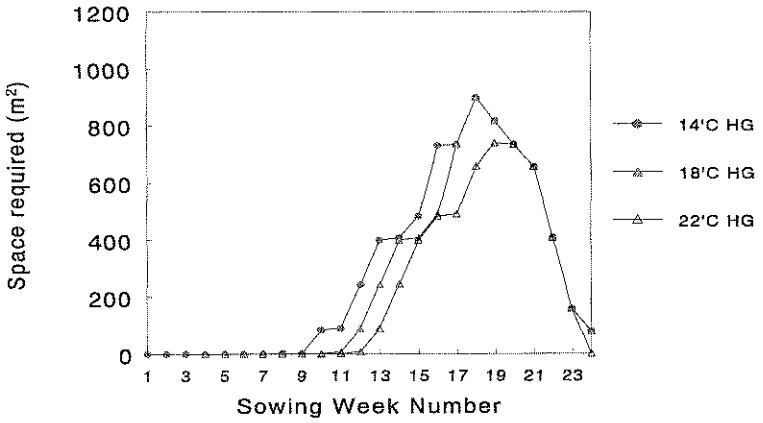


Figure A3.6.1. The area required for the typical production pattern of 100,000 pots.

Space Requirements of a Typical Production Pattern as a Percentage of 14 'C

Temperature	*14'C*	*18'C*	*22'C*
Pots/Packs	100%	88%	73%

The increase in temperature from 14'C to 22'C only reduces the total space requirement by about one quarter.

A3.7 Comparison of Heating Costs

Differences in heating costs and Total Profit (£000's) compared with 14'C.

Pots			
Temperature	*14'C*	*18'C*	*22'C*
Pots			
Increase in Heating Costs (£000)	0	0	0
Difference in			
Total Profit (£000)	0	1	2
Packs			
Increase in Heating Costs (£000)	0	1	2
Total Profit (£000)	0	5	12

Heating costs for this crop are increasing as the temperature rises. For pots the increases are relatively small, less than £500, which compares with an increase in *Total Profit* of about £2000. The pattern is more pronounced for the packs. Here the fuel cost rise is about £1000 whilst the *Total Profit* goes up by about £12000.

APPENDIX 5

A5.0 SALVIAS

A5.1 EFFECTS OF TEMPERATURE:

A5.1.1 Effects of Changing Sowing Dates Within Each Temperature Regime on the Production Regime

Salvias were grown at 14'C, 18'C and 22'C.

Home Grown Plugs		*Growing Period weeks rounded to whole weeks*		
		14'C	*18'C*	*22'C*
Sowing week	1	13	11	10
	9	12	11	10
	18	10	10	9

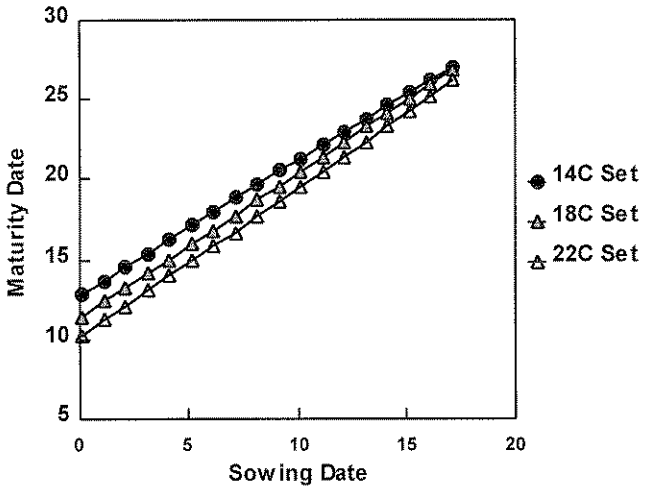


Figure 8.1.1 The sowing date schedules for salvias grown at 3 different temperatures

Home Grown Plugs		*Growing Period as % wk1*			*Temperature as % 14'C*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	100	100	100	100	85	77
	9	92	100	100	100	92	83
	18	77	91	90	100	100	90

The growing time for salvias is much less sensitive to increases in temperature or stage of season than any of the other crops.

A5.1.2 Comparison of the *Profit Margin* for the Different Sowing Dates within each Temperature Regime.

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	0	0	0	0	0
	9	15	5	6	16	5	6
	18	48	25	33	52	27	35

The muted physical response to date of sowing is reflected in trend in *Profit Margin*. Unlike most other crops (except impatiens) the higher temperatures show a lower increase in *Profit Margin* than 14'C as the season develops.

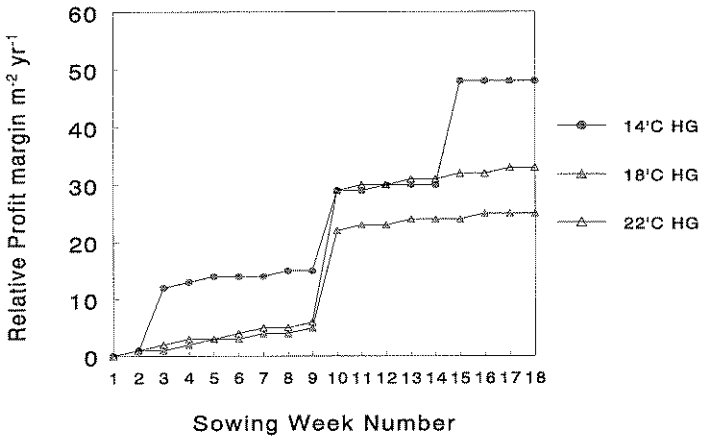


Figure A5.1.2 The relationship between sowing week number, temperature and *Profit Margin* for pot salvias from home grown plugs, assuming an overhead charge of £1.00 per square metre per week, data normalised to batch 1 as "0" at all temperatures.

A5.1.3 Comparison of Relative *Profit Margins* between Temperature Regimes by Sowing Date

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	22	36	0	24	40
	9	0	12	27	0	13	30
	18	0	-1	21	0	-1	23

The effect of increasing temperature is greater earlier in the season than later.

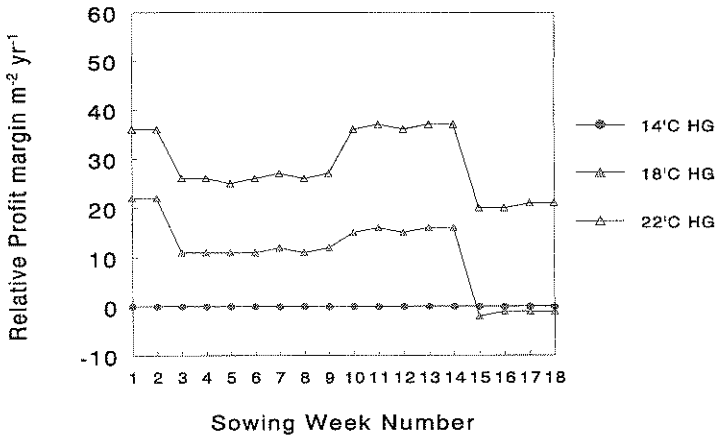


Figure A5.1.3. The effects of temperature and sowing week on *Profit Margin* for pot salvia from home grown plugs, at an overhead charge of £1.00 per square metre per week, data are normalised with the 14'C *Profit Margin* set at "0" in each week.

General Comments: Salvias are less responsive to temperature and probably light than other crops.

A5.2 Effects of Varying the Level of Overhead Costs:

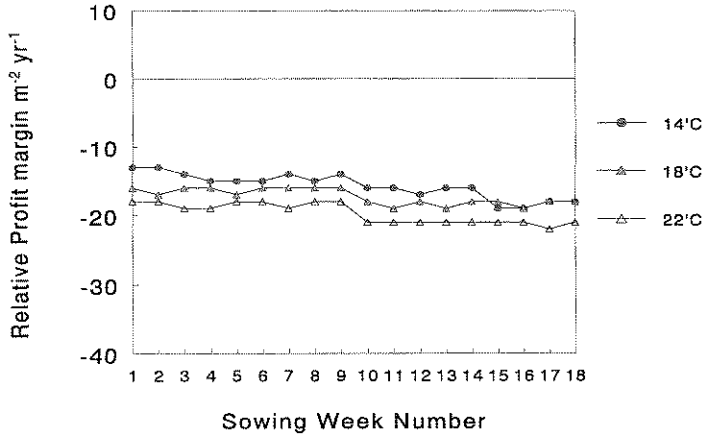
Increasing the overhead charge to £1.50 per square metre week reduces the *Profit Margin* for both pots and packs produced from home grown and bought-in plugs. Even so all remained positive.

A5.3 Effects of Buying in Plugs Viz Home Grown:

		Pots			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	-13	-16	-18	-22	-26	-30
	9	-14	-18	-18	-24	-27	-30
	18	-18	-18	-21	-30	-30	-33

The *Profit Margin* difference between home grown and bought-in plugs is less marked with salvias. They show the same pattern as geraniums.

Pots



Packs

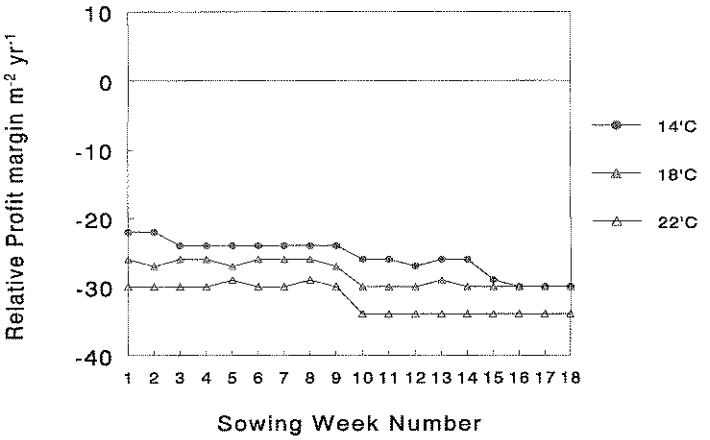


Figure A5.3.1 Reduction in *Profit Margin* when bought-in plugs are used for pots (A5.3.1a) and packs (A5.3.1b) salvias plugs, at an overhead charge of £1.00 per square metre per week. Data for crops grown from bought-in plugs normalised with the *Profit Margin* for comparable crops from home grown plugs set at "0" in each week.

A5.4 Effects of Varying Sale Price Levels:

A5.4.1 Actual Difference in *Profit Margin* between Standard Price and 10% Reduction

Home Grown Plugs	*Pots*			*Packs*		
	Profit Margin difference			*Profit Margin difference*		
	14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing Week 1	-17	-22	-43	-15	-18	-29
9	-19	-22	-35	-16	-18	-24
18	-24	-24	-27	-21	-21	-20

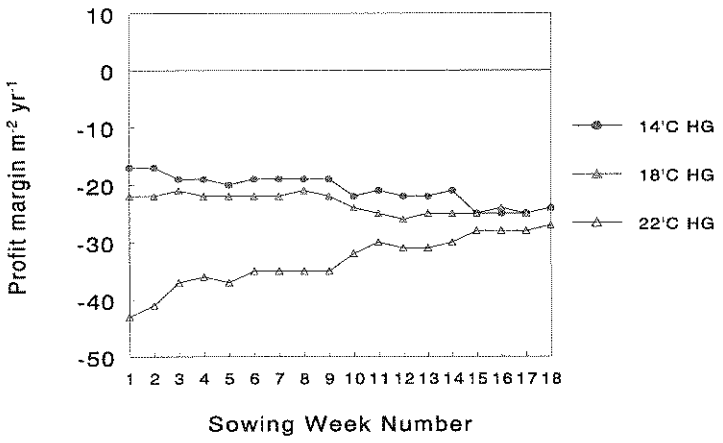


Figure A5.4.1. The effects of a 10% reduction in price of pot salvia expressed as actual differences compared with the relative *Profit Margin* at the full price.

Salvias show a reduction in *Profit Margin* which is in line with most other crops when there is a price reduction of 10%. Of more significance is the positive *Profit Margins* for all systems even after the reduction.

A5.5 Ranking of Husbandry Systems by Profitability:

Pot Production

Maturity Week	Temp. 'C	Propagating System	Sowing Week	No Weeks Growing	Relative PM Value.	Ranking
17	22	HG	8	7	42	1
	18	HG	7	8	27	2
	22	Buy	8	7	24	3
	14	HG	6	9	15	4
	18	Buy	7	8	11	5
	14	Buy	6	9	0	6
20	22	HG	12	6	65	1
	18	HG	11	7	44	2
	22	Buy	12	6	44	3
	14	HG	10	8	28	4
	18	Buy	11	7	25	5
	14	HG	9	9	14	4
	14	Buy	10	8	12	6
	14	Buy	9	9	0	6
23	22	HG	15	6	54	1
	22	Buy	15	6	33	**3**
	18	HG	14	7	32	**2**
	14	HG	13	8	16	4
	18	Buy	14	7	14	5
	14	Buy	13	8	0	6

The impact of temperature does not completely outweigh the price differential between home grown and bought-in plugs. Nor do the later batches show any indication of change.

A5.6 Overall Profitability of Systems:

A5.6.1 Total Profitability of All Batches:

Differences in Total Profit (£000's) compared with 14'C

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-5	1	-4	3	-2
Packs	0	-64	10	-54	22	-42

Once again the effect of increasing the temperature from 14'C to 22'C is to increase the *Total*

Profit by about £3000. The trends for packs and plug types are also similar to other crops.

A5.6.2 Profitability of Typical Production Pattern:

Differences in Total Profit (£000's) compared with 14'C

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-3	1	-2	2	-1
Packs	0	-36	7	-28	16	-19

Narrowing of the cropping pattern reduces the impact of both the temperature and the type of plug used.

A5.6.3 Space Requirements of Typical Production Pattern

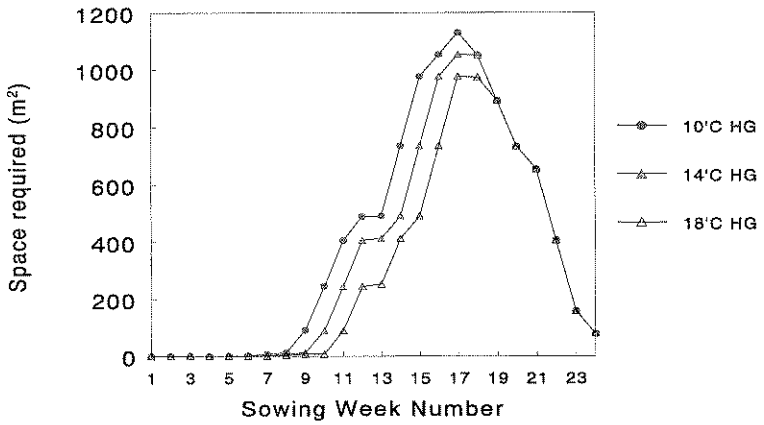


Figure 6.3 shows the area required for the typical production pattern of 100,000 pots.

The difference between the space requirements for the three temperature regimes are similar to those for impatiens. Both are relatively short duration crops.

Space Requirements of Typical Production Pattern as a Percentage of 14 'C

Temperature	14'C	18'C	22'C
Pots/Packs	100%	87%	74%

Although salvias seem to be less sensitive to temperature and sown date the impact on space

use for the commercial sales pattern is very similar to other crops.

A5.7 Comparison of Heating Costs

Differences in heating costs and Total Profit (£000's) compared with 14'C.

Temperature	*14'C*	*18'C*	*22'C*
Pots			
Increase in Heating Costs (£000)	0	0	0
Difference in Total Profit (£000)	0	1	2
Packs			
Increase in Heating Costs (£000)	0	1	2
Difference in Total Profit (£000)	0	7	16

The cost of heating the crops rises in line with the temperatures as does the *Total Profit* .

APPENDIX 4

A4.0 PETUNIAS

A4.1 EFFECTS OF TEMPERATURE:

A4.1.1 Effect of Changing Sowing Dates Within Each Temperature Regime on the Duration of Production

Petunias were grown at 14'C, 18'C and 22'C.

Home Grown Plugs		*Growing Period weeks*		
		14'C	*18'C*	*22'C*
Sowing week	1	19	15	13
	9	14	12	10
	18	10	10	8

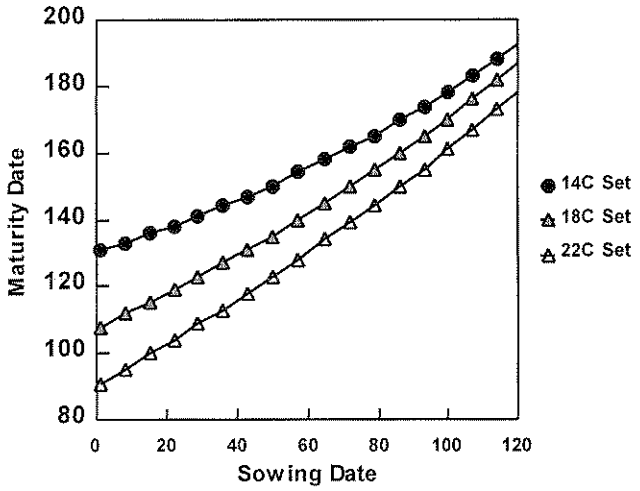


Figure A4.1.1 The sowing date schedules for petunias grown at 3 different temperatures, dates are in Julian days

Home Grown Plugs		*Growing Period as % wk1*			*Temperature as % 14'C*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	100	100	100	100	79	68
	9	74	80	77	100	86	72
	18	53	67	62	100	100	80

Petunias are about average in their response to temperature early in the season but this progressively disappears as the season progresses. In week 18 there is little difference in response between 14'C and 18'C and only a 20% improvement in time at 22'C.

They are much more responsive to the date of sowing.

A4.1.2 Comparison of the *Profit Margin* for the Different Sowing dates within each Temperature Regime.

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	0	0	0	0	0
	9	31	32	47	35	35	52
	18	84	67	107	94	74	119

The response to date of sowing in terms of *Profit Margin* is substantial but still rather less than the big differences shown by marigolds.

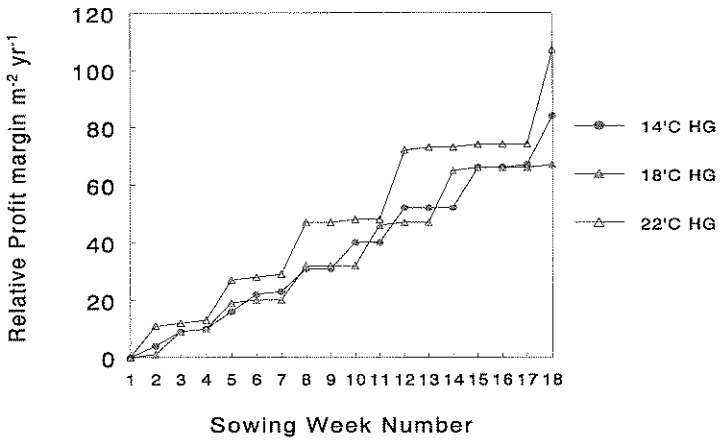


Figure A4.1.2. The relationship between sowing week number, temperature and *Profit Margin* for pot petunias from home grown plugs, assuming an overhead charge of £1.00 per square metre per week, data normalised to batch 1 as "0" at all temperatures.

A4.1.3 Comparison of Relative *Profit Margins* for different Temperature Regimes by Sowing Date

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	0	17	31	0	20	36
	9	0	18	47	0	20	53
	18	0	0	54	0	0	61

The effect of increasing temperature from 14' to 22'C is progressively greater later in the season. For the two lower temperatures this is a steady progression. The flattening of the physical response for week 18 at these temperatures is mirrored by the *Profit Margin.*

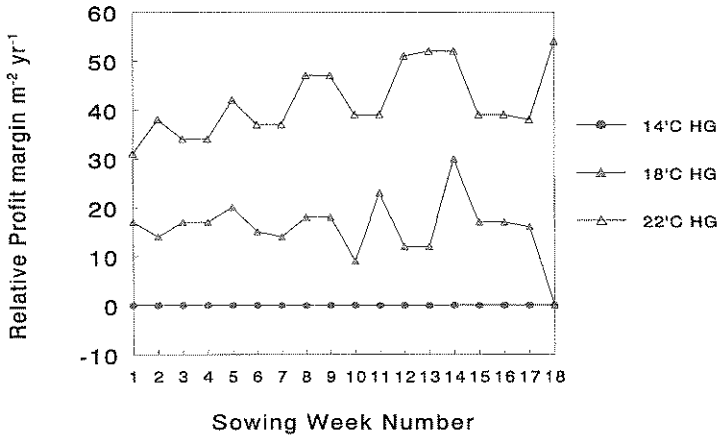


Figure A4.1.3. The effects of temperature and sowing week on *Profit Margin* for pot petunia from home grown plugs, at an overhead charge of £1.00 per square metre per week. Data are normalised with the 14'C *Profit Margin* set at "0" in each week.

General Comments: Petunias are less responsive to temperature and more responsive to date of sowing.

A4.2 Effects of Varying the Level of Overhead Costs:

The first five weeks of pot production at 14'C show a loss when the overhead charge is raised to £1.50 per square metre week. At 18'C the first two sowings show a loss. For packs the effect is not so great.

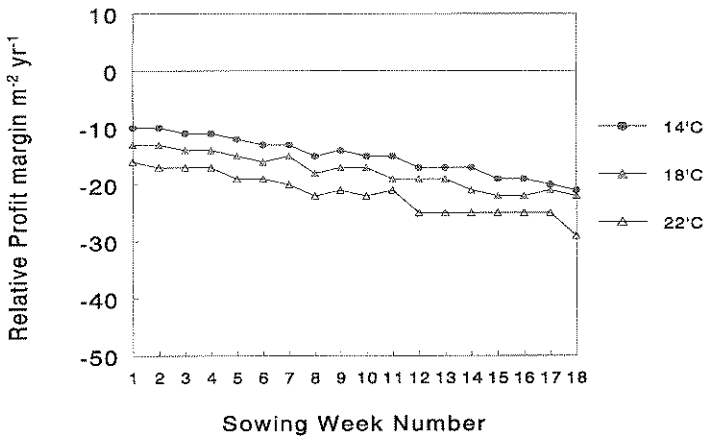
A4.3 Effects of Buying-in Plugs Viz Home Grown:

Pots		*Home Grown Plugs*			*Bought-in Plugs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing week	1	-10	-13	-16	-16	-21	-25
	9	-14	-17	-21	-23	-28	-35
	18	-21	-22	-29	-35	-36	-48

The *Profit Margin* difference between home grown and bought-in plugs is less marked with petunias. They show the same pattern as geraniums.

All except the first batch at 14'C show a *Profit Margin* with bought-in plugs.

Pots



Packs

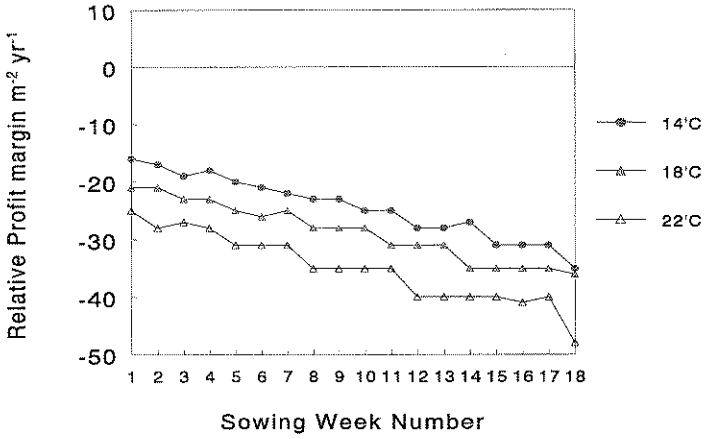


Figure A4.3.1 Reduction in *Profit Margin* when bought-in plugs are used for pots (A4.3.1a) and packs (A4.3.1b) petunia plugs, at an overhead charge of £1.00 per square metre per week. Data for crops grown from bought-in plugs normalised with the *Profit Margin* for comparable crops from home grown plugs set at "0" in each week.

A4.4 Effects of Varying Sale Price Levels:

A4.4.1 Actual Difference in *Profit Margin* Between Standard Price and 10% Reduction

Home Grown Plugs		*Pots*			*Packs*		
		Profit Margin difference			*Profit Margin difference*		
		14'C	*18'C*	*22'C*	*14'C*	*18'C*	*22'C*
Sowing Week	1	(-11)	-14	-17	-9	-14	-15
	9	-16	-19	-24	-14	-19	-21
	18	-24	-25	-34	-21	-25	-29

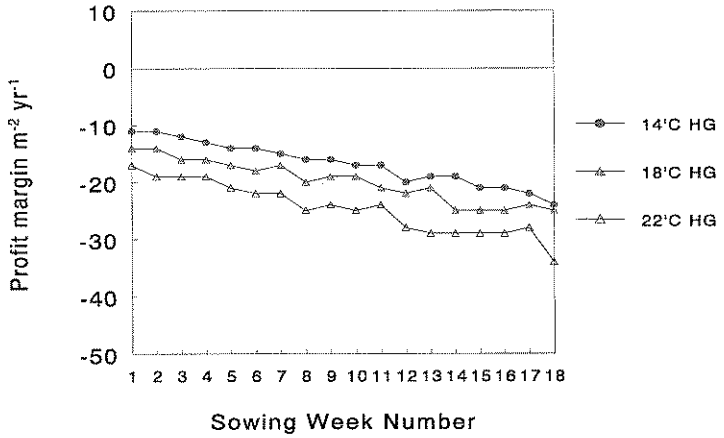


Figure A4.4.1. The effects of a 10% reduction in price of petunia expressed as actual differences compared with the *relative Profit Margin* at the full price.

Petunias show a reduction in *Profit Margin* which is in line with most other crops when there is a price reduction of 10%. Of more significance are the overall losses which occurred in the early sowings at 14'C.

A.4.5 RANKING OF HUSBANDRY SYSTEMS BY PROFITABILITY:

Pot Production

Maturity Week	Temp. 'C	Propagating System	Sowing Week	No Weeks Growing	Relative PM Value.	Ranking
17	22	HG	7	7	65	1
	22	HG	8	8	47	1
	22	Buy	7	7	43	2
	22	Buy	8	8	27	2
	18	HG	5	10	23	3
	18	HG	4	11	14	3
	18	Buy	5	10	8	4
	18	Buy	4	11	0	4
20	22	HG	12	6	104	1
	22	HG	11	7	80	1
	22	Buy	12	6	79	2
	22	Buy	11	7	59	3
	18	HG	9	9	50	4
	18	Buy	9	9	33	5
	14	HG	6	12	23	5
	14	HG	5	13	17	5
	14	HG	4	14	11	6
	14	Buy	6	12	10	6
	14	Buy	5	13	5	6
	14	Buy	4	14	0	6
23	22	HG	15	6	80	1
	18	HG	14	7	57	3
	22	Buy	15	6	55	2
	18	HG	13	8	39	3
	18	Buy	14	7	36	4
	14	HG	12	9	27	5
	18	Buy	13	8	20	4
	14	HG	11	10	15	5
	14	Buy	12	9	1	6
	14	Buy	11	10	0	6

For sales weeks 17 and 20 the impact of temperature outweighs the price differential between home grown and bought-in plugs. This is not so clear for sales week 23.

A4.6 Overall Profitability of Systems:

A4.6.1 Total Profitability of All Batches:

Differences in Total Profit (£000's) compared with 14'C home grown

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-6	3	-3	7	0
Packs	0	-75	24	-51	48	-27

For pots the *Total Profit* increases steadily with increase in temperature. This increase is greater than most other crops. It increases to the point when even the bought-in plugs at 22'C have a similar *Total Profit* to the home grown at 14'C.

A4.6.2 Profitability of Typical Production Pattern:

Differences in Total Profit (£000's) compared with 14'C home grown

	14'C		*18'C*		*22'C*	
Plug Source	*Home*	*Buy*	*Home*	*Buy*	*Home*	*Buy*
Pots	0	-3	5	2	8	5
Packs	0	-41	34	-7	55	14

The shortening of the production pattern serves to highlight the overall improvement to *Profit Margin* from increased temperature.

A4.6.3 Space Requirements of Typical Production Pattern

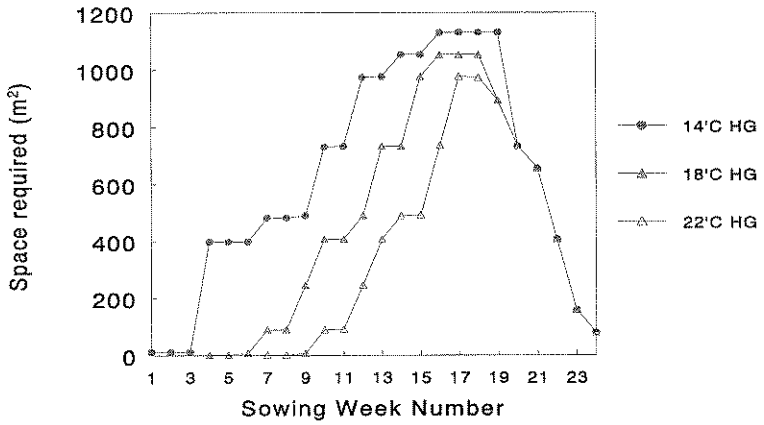


Figure A4.6.3 shows the area required for the typical production pattern of 100,000 pots.

The difference between the space requirements for the three temperature regimes are similar to those for impatiens. Both are relatively short duration crops.

Space Requirements of Typical Production Pattern as a Percentage of 14 'C

Temperature	14'C	18'C	22'C
Pots/Packs	100%	70%	50%

Despite the apparent modest impact of temperature in relation to sowing date the total space use for the whole crop shows a reduction of about half between 14'C and 22'C.

A4.7 Comparison of Heating Costs

Differences in heating costs and Total Profit (£000's) compared with 14'C.

Temperature	*14'C*	*18'C*	*22'C*
Pots			
Increase in Heating Costs (£000)	0	0	0
Difference in			
Total Profit (£000)	0	5	8

Packs			
Increase in Heating Costs (£000)	0	-1	-2
Difference in Total Profit (£000)	0	34	55

The cost of heating the crops actually falls as the temperature increases for packs, and to a lesser extent for pots. This is a result of the reduction in space/ time use which is greater than the increase in unit cost of heating.

Not surprisingly this results in a major increase in *Total Profit*.

Optimising Returns in Bedding Plant Production

Background and Related Work

Over the last three year HDC funded research at the University of Reading has examined the effects of the temperature, light level and daylength on the growth and flowering of a range of bedding species including Petunia, Geranium, Impatiens, Pansy, Antirrhinum, Salvia and Marigold. The data has been analysed in terms of mathematical models that can be used to predict time to flowering and quality of plants grown at a diverse range of environmental conditions. These models have led to the development of a number of sowing date schedules for Pansy, Geranium and Petunia crops grown at a range of temperatures. Thus, the volume of information gained from these studies has been considerable, however, to date the models do not consider the returns and profitability of various schedules or growing strategies. For example, higher temperatures will usually shorten time to flowering leading to greater throughput, but result in higher fuel costs. Higher temperatures may also reduce quality, which will decrease returns, equally the cooler temperatures result in longer growth periods and increased space/time requirements

In order to help growers evaluate the most profitable growing schedules the relative cost benefits of these schedules need to be calculated. At the same time it is important to have an indication of the sensitivity of these relativities to changes in heating costs, to varying cost levels of space/time usage etc.

Financial Benefit to the Industry

The benefits of any proposed research program are always difficult to quantify. However, this proposal would have two benefits, firstly it would maximise the HDC's return for their investment in the Reading research program, since growers would gain additional information on the most profitable growing strategies. Thus, growers would benefit through an increased knowledge of profitable growing techniques. Furthermore, the study will identify the relative importance of the various parameters that affect profitability, for example the trade off when raising temperature between increased fuel costs and greater throughput. In an industry worth £450M an increase in profitability of a very few percentage points would equate to a substantial sum.

Commercial Objectives of the Proposed Research

The objectives of this proposed study are:

I. To provide clear easily understood technical and economic guidance for growers, to enable them to make full use of the production schedules developed at the University of Reading.

II. To help them maximise their returns through the use of these schedules.

This will be achieved by using the bedding plant schedules, developed at Reading, plus typical financial data, in an existing software package specifically designed to undertake the physical and financial planning of bedding and pot plants. The results will then be represented in a

relative and grower friendly format. These will then be used in specially arranged technology transfer workshops for selected growers.

Procedure

The work can be broken down into four main sections;

I. The University of Reading will provide schedules for the following species: Antirrhinum, Geranium, Impatiens, Marigold, Pansy, Petunia and Salvia. They will also make predictions on the commercial quality produced (SP).
II. The methodology will be established. This will include the scale of production, the size of the pots and packs to be used, the methods of production eg seedling or brought in or home produced plugs, the spacing regimes to be followed, typical physical / labour data will be used for the main production operations etc (GJC/SC/SP)
III. Financial data. Typical variable costs will be obtained for each type of production and crop. Typical overhead costs will be obtained from the selected small, medium and large scale growers. Sale prices for differing quality standards will be estimated. (GJC/SC).
IV. Inputting data into software: 7 crops each with a season of 18 weeks, 5 temperatures, 3 scales of production (small, medium and large), 2 production systems (seedling or plugs) and all other financial and physical data. (GJC).
V. Interpreting data and undertaking sensitivity analysis in particular with heating and space/time costs.
VI. The presentation of the data in a simple and grower friendly format. This will probably take the form of a suitably annotated, simple two dimensional graphs. After consultation with the BBPPA technical committee it was agreed that the final report will contain no data on the absolute returns from the various simulations. All the data will be reported in terms of the relative (percentage) benefits of one scenario against another. This is to ensure commercial confidentiality.
VII. Information transfer. The writing up of the report for HDC, the preparation of fact sheets for publishing by the HDC, the presentation of the results of the study to two selected groups of growers as part of suitable workshops.

Project Leaders

Graham Jones (GJ Consultants)
Dr. Simon Pearson (University of Reading)
Stuart Coutts

Costs

GJ Consultancy	£3000
University of Reading	£2000
Stuart Coutts	£ 500

Reporting Time

The project will commence in November for a period of four months. This will ensure the information is available for the next bedding season.