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CONTRACT REPORT

New Guinea Impatiens:
The potential for extending the growing season,
improving plant production and shelf-life properties
using cultural and chemical means

Part II (1994)
Effect of nutrition

HDC PC80a

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Final Report March 1996

HDC PC80a

New Guinea Impatiens: The potential for extending the growing season, improving plant production and shelf-life properties using cultural and chemical means

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1. RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

1.1 APPLICATION

The effects of different conductivity regimes were examined on six cultivars of New Guinea Impatiens, specifically the effect of electrical conductivity (EC) on flowering. High EC levels, 3.3 and 4.9 mS, produced more compact growth and much darker foliage. Aruba and Maui suffered from severe leaf scorch at 4.9 mS, whereas Barbados, Dorte and Vulcain were able to withstand higher ECs. There was no significant effect of nutrition on flowering, in terms of flower initiation or development but flower size and colour were reduced at higher conductivities. Although high conductivities were detrimental in the later stages of growth and shelf-life, it appeared they had potential to control plant growth and improve plant habit in the earlier stages of production. All cultivars grown were able to withstand EC levels up to 3.3 mS.

Commercial trials evaluating a wide range of cultivars identified those which showed potential as both a bedding plant and pot plant.

1.2 SUMMARY

Nutrition can play an important role in plant growth, flowering and final plant quality and shelf-life. New Guinea Impatiens require the same essential nutrients as for most other flowering plants, but there is a paucity of knowledge on the response of New Guinea Impatiens to different nutrient regimes, specifically electrical conductivity (EC).

This trial (PC 80a, Part II), funded by the HDC, set out to determine the effect of nutrition on plant growth and flowering of New Guinea Impatiens. A wide range of treatments were employed, and assessments of flowering and plant growth were taken after three, six and nine weeks. Plants were subjected to further assessments to examine the effect of cultural practices on shelf-life. An additional trial was included to investigate the effect of photoperiod on flowering.

Two commercial trials were undertaken by ADAS on four commercial holdings to evaluate a large number of new cultivars for their suitability in commercial production as both pot or bedding plants.

1.2.1 METHODOLOGY

A HRI EFFORD

Start Material

Plants were supplied as rooted cuttings from Dummens through Hollyacre Plants Ltd. Plants were potted in week 23.

Cultivars

Paradise Types	**Others (Classical Types)**
Aruba	Anaea
Barbados	Dorte
Maui	Vulcain

Treatments

Plants were grown using a 2:1:4 nutrient ratio of N:P:K liquid feed commencing immediately after potting. The conductivity of the applied feed was adjusted to provide four treatments:

1. 0.9 mS
2. 1.7 mS
3. 3.3 mS
4. 4.9 mS

In addition to these four main nutritional treatments a number of plants were transferred between treatments at 3 and 6 weeks post potting. This regime resulted in plants that were grown at alternating conductivity levels i.e. high/low and low/high, throughout production.

Photoperiod Treatment

Plants were grown in either 16 hour or 12 hour daylengths under ambient light levels. At four weeks post potting a number of plants were transferred between treatments so that plants experienced 4 weeks in 'long' days and subsequently in 'short' days, and the reciprocal treatment.

B COMMERCIAL TRIALLING: POT PLANTS

Sites

Four grower holdings participated in trials evaluating a range of New Guinea Impatiens cultivars as a commercial pot plant crop. The four sites were:

C & A Benson Ivanda Nurseries Spalding	H Evans & Sons Ltd Europa Nursery Kent
Nielsen Plants Danecroft Nursery East Sussex	Helmut Gimmler Limited Double H Nurseries Hampshire

In addition to the above four sites, P A Moerman in Spalding at the Raceground Nursery also conducted a trial evaluating cultivars supplied by Selecta Klemm (SK).

Start Material

Plants were supplied as rooted cuttings from Royal Eveleens (E), Dummen (D) and Fides (F). Plants were potted in week 22/23, 1994.

Cultivars

Allegro (D)	Largo (D)
Anaea (E)	Selenia (F)
Barbados (F)	Viola (D)
Concerto (D)	Vivace (D)
Dorte (F)	Vulcain (E)
Lanai (F)	

Plants supplied to P A Moerman from Selecta Klemm in week 15 were:

Gardia	Helsinki	Imperia
Hagi	Hong Kong	Ivrea
Hailum	Hudson	Izmir
Hanko	Heulva	Kairo
Harlem	Imola	Kampala
Heidelberg		

C. COMMERCIAL TRIALLING: BEDDING PLANTS

Sites

A trial was conducted in the summer of 1994 at the Springfields Garden Site in Spalding to evaluate the performance of a range of cultivars as bedding plants.

Start Material

Rooted cuttings were supplied by Selecta Klemm (SK) and Dummen (D). Plants were grown on a commercial nursery in Spalding before being planted at Springfields in week 26, 1994.

Cultivars

Gardia (SK)	Helsinki (SK)	Imperia (SK)	Allegro (D)	Kanon (D)
Hagi (SK)	Hong Kong (SK)	Ivrea (SK)	Bourree (D)	Motette (D)
Hailum (SK)	Hudson (SK)	Izmir (SK)	Cambo (D)	Opera (D)
Hanko (SK)	Heulva (SK)	Kairo (SK)	Concerto (D)	Sarabunde (D)
Harlem (SK)	Husum (SK)	Kampala (SK)	Glissando (D)	Sinfoine (D)
Heidelberg (SK)	Imola (SK)	Adigio (D)	Harmonie (D)	Sonate (D)

1.2.2 RESULTS

A HRI EFFORD

The cultivars Barbados and Maui were quickest into flower, whilst Aruba and Dorte were much slower.

In the first 6 weeks, Barbados and Anaea flowered more profusely at the lower nutrient treatments, 0.9-1.7 mS, and less well at 4.9 mS. There was no effect of nutrition on the flowering of Vulcain or Maui at this stage. In general plant growth at 0.9 and 1.7 mS was paler and more vigorous/vegetative, whereas at the higher nutritional treatments, 3.3 and 4.9 mS, plant growth was more compact with a much darker foliage colour. Slight leaf scorch was apparent on the cultivars Aruba and Maui.

At marketing (9 weeks) Aruba, Barbados and Maui had greater flowering scores, and there were some effects of nutrition apparent on flowering. The worst flowering score was where plants were grown in the early stages at 1.7 mS then moved to a lower feed of 0.9 mS. The best flowering scores were where plants had been grown for their first 3 weeks at 1.7, 3.3 or 4.9 mS and then transferred to 4.9, 0.9 and 1.7 mS respectively. There was no significant effect of nutrition on the number of buds recorded.

Plant height was, on average, increased at 0.9 and 1.7 mS in comparison to plants grown at 3.3 or 4.9 mS which were more compact and with very dark foliage. Interestingly, Vulcain had lost its variegation at these treatment levels. Anaea appeared to be affected less by nutrition in contrast to the other cultivars. Plant height of Aruba, Maui and Vulcain were significantly reduced at 4.9 mS, and both the cultivars Aruba and Maui suffered from severe leaf scorch.

Plants grown at 4.9 mS for their final 3 or 6 weeks of production were of much poorer quality at marketing and suffered badly from premature bud and flower drop in shelf-life.

The effect of photoperiod on flowering was unclear as daylength and light integral were not separated within the context of this trial. Plants grown continuously in 'long' days appeared more floriferous.

The commercial trial objectives, to evaluate a wide range of cultivars as both pot plants and bedding plants was successful in drawing up a 'shortlist' of the better cultivars (as decided by a panel of growers who scored each variety at maturity and in bedding out assessments). The cultivars Gardia and Imola proved to be suitable as both a flowering pot plant and as a bedding plant.

1.2.3 CONCLUSIONS

- Nutrition had a marked effect on plant growth with increased conductivity causing more compact growth. At levels above 3.3 mS high conductivity can cause severe leaf scorch or even plant death.

- Nutrition had little effect on flower initiation or development, but high conductivity levels reduced flower size and colour.

- Aruba and Maui were more sensitive to high conductivity levels in the growing media.

- Cultivars trialled were able to withstand irrigation with feed having an electrical conductivity of up to 3.3 mS.

- High EC levels at marketing were detrimental to shelf-life.

- New cultivars were generally of better quality, being more compact, floriferous and were grown successfully as both pot and bedding plants.

As pot plants	**As bedding plants**
Gardia	Gardia
Hanko	Harlem
Heidelberg	Heulva
Imola	Imola
Imperia	Adigio
Ivrea	Motette
	Kanon

2. EXPERIMENTAL SECTION

2.1 INTRODUCTION

New Guinea Impatiens production and sale has grown rapidly over the past 5-10 years, and in Europe it is estimated near to 100 million plants are produced annually. With such rapid growth in production it is surprising that with the exception of earlier HDC study, PC 80, little research has been conducted on this crop, and in fact very little knowledge exists on the growth and flowering of New Guinea Impatiens in response to their growing environment.

The first introduction of commercial varieties into the UK was around 15 years ago. However, this introduction failed to make a great impact due to their small flower size, long stem internodes and poor branching. The first major advance in their popularity was the development of new cultivars by the breeder/propagator Mikklesens, who introduced the Sunshine series about 10 years ago. Their improved flower size, colour range and habit made New Guinea Impatiens an instant success. From the Sunshine series, the German propagator Ludwig Kientzler continued the improvement with the introduction and release of the Paradise series in 1991. This group was particularly compact, floriferous and early flowering. This was a major breakthrough and the Paradise series continues to dominate the UK market.

With such a wide range of new cultivars entering into the UK market it was important that an independent assessment of these cultivars was done to evaluate their performance both as an indoor potted plant and as an outdoor bedding/patio plant. Thus, with this objective in mind, the HDC funded two commercial trials with ADAS. Plants were assessed over the main summer production period on four commercial holdings, and plants for outdoor assessments were planted at the trial grounds at Springfield, Lincolnshire. The results of these assessments are incorporated in this report.

New Guinea Impatiens require the same essential nutrients as most other flowering pot plants. However, in commercial production there have been incidences where nutrition has been thought to cause poor plant growth. Poor plant performance has often been attributed to excess nutrition and associated high salt levels, but there is a paucity of knowledge on the response of New Guinea Impatiens to different nutrient regimes.

As the second component to the HDC funded study in 1994 (PC 80a), the effect of nutrition on plant growth and flowering of New Guinea Impatiens was therefore assessed using a summer crop which would potentially require a high irrigation/nutrition input. Plants were grown under controlled glasshouse conditions at HRI Efford.

An additional trial investigated the effect of photoperiod on flowering.

New Guinea Impatiens are thought to have a poor shelf-life, with plants dropping their flowers and buds rapidly. Plants were subjected to a final assessment in a simulated shelf-life environment to quantify the effects of nutrition on shelf-life.

2.2 OBJECTIVES

- To investigate the effect of nutrition, specifically conductivity of the applied feed, on plant growth and flowering.

- To evaluate the effect of nutrition on shelf-life performance.

- To evaluate a range of cultivars for their suitability as an indoor potted plant, and as an outdoor bedding/patio plant.

- To investigate the effect of photoperiod on plant growth and flowering.

2.3 MATERIALS AND METHODS

A HRI EFFORD

2.3.1 Site

Plants were grown in four ebb and flood compartments of the multifactorial glasshouse K block at HRI Efford.

2.3.2 Start Material

Plants were supplied as rooted cuttings from Dummens through Hollyacre Plants Ltd. Plants were potted in week 23.

Cultivars

Paradise Types	**Others (Classical types)**
Aruba	Anaea
Barbados	Dorte
Maui	Vulcain

2.3.3 Treatments

Plants were grown using a 2:1:4 nutrient ratio of N:P:K liquid feed commencing immediately after potting. The conductivity of the applied liquid feed was adjusted to provide four treatments:

1. 0.9 mS
2. 1.7 mS
3. 3.3 mS
4. 4.9 mS

(These figures included background EC of the irrigation water - analysis of mains water used at Efford is shown in Appendix I, page 31.)

In addition to these four main nutritional treatments a number of plants were transferred between treatments at 3 and 6 weeks post potting. This regime resulted in plants that were grown at alternating conductivity levels i.e. high/low and low/high, throughout production.

A further trial investigated the effect of photoperiod on plant growth and flowering at high light intensities experienced during the summer. Levels of solar radiation are shown in Appendix X, page 49.

1. 16 hours 'long' days, 8 hours night
2. 12 hours 'short' days, 12 hours night
3. plants grown for 4 weeks in 'long' days then transferred to 'short' days
4. plants grown for 4 weeks in 'short' days then transferred to 'long' days

Plants grown in 'short' days were blacked out from 2000 hrs until 0800 hrs using a typical blackout/reflective material (AYR Chrysanthemum type).

2.3.4 Experimental Design

The trial was unreplicated with each of the four compartments comprising a single nutrition treatment. Plants were blocked by cultivar, and cultivar plots were in the same geographical location in each of the four compartments.

6	cultivars
x	
4	nutritional treatments
x	
<u>8</u>	transfers/interchange of nutritional treatments
192	plots

Each plot had 15 plants arranged in 3 rows of 5 plants each. After 3 weeks and 6 weeks each group of 15 plants were moved between plots within varieties or between compartments. This ensured systematic effects of position were reduced and that all plants moved twice during the trial. The varietal blocks were kept parallel to the centre drain on each flood floor to ensure all plants of the same variety were in the same depth of nutrient feed for each irrigation.

2.3.5 Cultural Details

The rooted cuttings were potted into 13C terracotta pots using VAPO BO peat. The pH was corrected to 5.5 using 2.25 kg/m^3 of dolimitic limestone and 2.25 kg/m^3 of ground limestone. Trace elements were provided by adding 0.4 kg/m^3 255 W/m^2 fritted trace elements. Analysis of the media at potting is given in Appendix II, page 32. Plants were placed pot thick into each of the glasshouse compartments and immediately watered in from above using mains water. Subsequently, plants were irrigated from below on the ebb and flood floors using the appropriate nutrient regime.

Plants grown for the photoperiod trial were potted using Levington C2 growing media.

Temperature: plants were grown at a minimum heating set point of 18°C with vents set to open at 21°C day/night.

Carbon Dioxide: there was no carbon dioxide enrichment.

Humidity: there was no direct humidity control other than ensuring compartment floors were 'damped down' regularly to maintain a minimum relative humidity of 70% whilst plants remained pot thick in the first 2 weeks after potting.

Irrigation: plants were sub-irrigated using the ebb and flood floors.

Lighting: none

Plant spacing: plants remained pot thick for 2 weeks (59 plants/m^2). At the end of 2 weeks plants were given an intermediate spacing of 40 plants/m^2. Plants continued to be grown at this spacing until 5 weeks post potting when plants of all cultivars were spaced to 20 plants/m^2.

Pinching: Plants were not pinched.

Shading: Plants were shaded when necessary using a 40% Ludwig Svensson shading screen set to shade at light levels >450 W/m^2.

Plant growth regulation: No chemical plant growth regulator treatments were applied.

Nutrition: Immediately from potting, a 2:1:4 NPK feed was applied at an EC as stated in each of the treatments.

Product	**Grammes/litre**
Mono-Ammonium Phosphate	9
Potassium Nitrate	87
Ammonium Nitrate	25
Calcium Nitrate	14

Analysis of the applied feed for each treatment is given in Appendix III, page 33.

Pest and Disease Control

An Integrated Pest Management programme was employed throughout the duration of the trial. Details are given in the Crop Diary, Appendix IV, page 34.

2.3.6 Assessments

Growing Media Analyses

A number of growing media analyses were taken throughout the trial across cultivars from all treatments. Media samples were taken at potting, and at 3, 6 and 9 weeks post potting.

Plant Growth Assessments at Marketing

When 50% of the plants had reached marketing stage (4-5 open flowers), assessments were made which included:

Plant Height	-	measured from the base of the plant to the top of its canopy
Bud Score (0-4)	-	0 = zero; 1 = 1-10; 2 = 11-20; 3 = 21-40 and 4 = 40+
Flower Score (0-4)	-	0 = zero; 1 = 1-2; 2 = 3-5; 3 = 6-10 and 4 = 10+
Plant Quality (0-2)	-	0 = marketable; 1 = Grade II plant; 2 = Grade I plant

Shelf-life

In shelf-life the following assessments were made on a weekly basis for three weeks:

Number of open flowers
Number of flowers fallen
Number of visible buds
Number of visible buds fallen
Number of leaves fallen

Photographs

Comparisons of plant growth were recorded at marketing and at the end of shelf-life.

2.3.7 Statistical Analysis

Statistical analysis was limited as the size of the trial did not allow for complete replication of all treatments. Where possible data were analysed using standard Analysis of Variance (ANOVA) or Regression analysis. The degrees of freedom (d.f.), standard error (SED), and probability (P) on which the significance tests were based are presented where appropriate in the tables to aid interpretation of the results. Statistical terms referred to are:

SED	=	The standard error of the difference when comparing two figures in that column of data.
P	=	The likelihood that the result was obtained by chance and hence not a true treatment effect.

P	=	<0.1	=	1 chance in 10
P	=	<0.01	=	1 chance in 100
P	=	<0.001	=	1 chance in 1000

NS	=	Not significant.

B. COMMERCIAL TRIALLING: POT PLANTS

2.3.8 Site

Four grower holdings participated in trials evaluating a range of cultivars as a commercial pot plant crop. The four sites were:

C & A Benson
Ivanda Nurseries
Spalding

H Evans & Sons Limited
Europa Nursery
Kent

Nielsen Plants
Danecroft Nursery
East Sussex

Helmut Gimmler Limited
Double H Nurseries
Hampshire

In addition to the above four sites, P A Moerman in Spalding at the Raceground Nursery also conducted a trial evaluating cultivars supplied by Selecta Klemm (SK).

2.3.9 Start Material

Plants were supplied as rooted cuttings from Royal Eveleens (E), Dummen (D) and Fides (F). Plants were potted in week 22/23, 1994.

Cultivars

Allegro (D)
Anaea (E)
Barbados (F)
Concerto (D)
Dorte (F)
Lanai (F)
Largo (D)
Selenia (F)
Viola (D)
Vivace (D)
Vulcain (E)

Plants supplied to P A Moerman from Selecta Klemm in week 15 were:

Gardia
Hagi
Hailum
Hanko
Harlem
Heidelberg
Helsinki
Hong Kong
Hudson
Heulva
Imola
Imperia
Ivrea
Izmir
Kairo
Kampala

2.3.10 Culture

Plants grown at the four main sites were potted in weeks 22-23. Plants were grown as a normal commercial crop in 13 cm pots. With the exception of plants grown at Ivanda Nurseries (14 plants/m^2), all other plants were grown at a final spacing of 20 plants/m^2.

Plants which were grown at Raceground Nursery, Spalding were potted earlier in week 15 and grown as a 10 cm commercial crop.

2.3.11 Assessments

Plants from all sites were assessed 9 weeks after planting. Records included:

Flower Score*	-	from 0-5, 5 = full flower.
Plant Vigour Score	-	from 0-5, 5 = good vigour and habit.
Plant Height	-	from pot rim to top of canopy.
Leaf Colour		
Flower Colour		

* This was the only record to be done at each of the four main grower sites, with the aim to examine the effect of cultural practices on flowering.

C. COMMERCIAL TRIALLING: BEDDING PLANTS

2.3.12 Site

A trial was conducted in the summer of 1994 at the Springfields Garden Site in Spalding to evaluate a range of cultivars in their performance as bedding plants.

2.3.13 Start Material

Rooted cuttings were supplied by Select Klemm (SK) and Dummen (D). Plants were grown on a commercial nursery in Spalding before being planted at Springfields in week 26, 1994.

Cultivars

Gardia (SK)	Helsinki (SK)	Imperia (SK)	Allegro (D)	Kanon (D)
Hagi (SK)	Hong Kong (SK)	Ivrea (SK)	Bourree (D)	Motette (D)
Hailum (SK)	Hudson (SK)	Izmir (SK)	Cambo (D)	Opera (D)
Hanko (SK)	Heulva (SK)	Kairo (SK)	Concerto (D)	Sarabunde (D)
Harlem (SK)	Husum (SK)	Kampala (SK)	Glissando (D)	Sinfoine (D)
Heidelberg (SK)	Imola (SK)	Adigio (D)	Harmonie (D)	Sonate (D)

2.3.14 Culture

All plants were grown as per a commercial crop in a 10 cm pot.

Plants supplied as rooted cuttings were potted in week 15, and planted outside in week 26, 1994. At planting, plants were spaced at 30 cm intervals. Following watering in post planting no further cultural practices (e.g. dead heading) were carried out except for hand-weeding.

2.3.15 Assessments

Plants were assessed 7 weeks after planting. The following records were taken:

Flower Score	-	score from 0-5, 5 = full flower cover
Plant Vigour Score	-	score from 0-5, 5 = good vigour and habit
Plant Height	-	measured from soil surface to top of canopy
Leaf Colour	-	light/mid/dark green leaf and if variegated
Flower Colour		

Additional comments were recorded, where applicable, on cultivar characteristics.

3. RESULTS

A. HRI EFFORD

3.1 AFTER 3 WEEKS GROWTH

3.1.1 Flowering Score

No plants were in flower at the end of 3 weeks.

3.1.2 Bud Score

After 3 weeks there were no significant differences between nutrient regime, but there were differences between the percentage of plants with bud scores greater than zero (Table 1).

Table 1 **Percentage of plants with visible buds after 3 weeks**

Cultivar	Treatment 0.9mS	1.7mS	3.3mS	4.9mS	Mean
Anaea	96	100	85	85	92
Aruba	35	28	11	25	25
Barbados	96	71	82	61	78
Dorte	64	85	75	67	77
Maui	78	89	93	78	85
Vulcain	53	89	82	82	77
Mean	71	77	71	67	

Aruba had a very poor response with only 25% of plants with bud scores greater than zero; Anaea (92%) and Maui (85%) were the best cultivars after 3 weeks.

3.1.3 Plant Growth

At the end of 3 weeks and immediately prior to the first transfer of plants between nutrient regimes there were no obvious differences in plant growth.

3.1.4 Growing Media Analyses

After 3 weeks, analysis of the substrate from each nutrient regime revealed differences in EC, and general levels of nitrogen, potassium, calcium and phosphorus. pH of the media was similar across treatments. (Appendix V, Table 1, page 35).

3.2 AFTER 6 WEEKS GROWTH

3.2.1 Flowering Score

Aruba and Dorte had a significantly smaller percentage of plants with flower score >1 than Anaea, Barbados, Maui and Vulcain (Table 2).

Table 2 Effect of nutritional regime on the percentage of plants with flower score >1

	Treatments						
Cultivar	**0.9**	**1.7**	**3.3**	**4.9**	**0.9→4.9**	**4.9→0.9**	**Mean**
Anaea	81	100	75	94	100	75	81
Aruba	31	37	25	37	50	75	30
Barbados	100	81	87	75	75	75	85
Dorte	44	56	50	25	75	100	54
Maui	81	94	94	94	100	100	91
Vulcain	56	94	94	75	100	100	81
Mean	65	77	71	67	83	87	

Barbados and Maui had the largest mean flowering scores. There was no significant difference between the nutritional regimes for Vulcain and Maui. Barbados had significantly more flowers in the 0.9 mS treatments than in any other nutritional treatment during the same period. Anaea flowered best when grown at 0.9 or 1.7mS, and less well at the higher nutritional treatment, 4.9 mS (Appendix VI, Table 1, page 38).

3.2.2 Bud Score

All plants had bud scores greater than zero, and there were no significant differences between the nutritional regimes after 6 weeks. Dorte and Aruba had the highest bud scores. Since these cultivars had the smallest mean flower scores this may simply indicate that these cultivars were slightly slower to flower than the others. (Appendix VI, Table 2, page 38).

3.2.3 Plant Growth

At the end of 6 weeks clear differences were evident between nutritional treatments. In general plant growth at 0.9 and 1.7 mS was paler and more vegetative/vigorous, whereas at the higher nutritional treatments, 3.3 and 4.9 mS plant growth was more compact and foliage colour very dark. Slight leaf scorch was apparent on the cultivars Aruba and Maui.

3.2.4 Growing Media Analysis

At 6 weeks the levels of nutrients had risen rapidly in the higher nutritional treatments. Levels of nitrate (as N), potassium and calcium were considerably higher in concentration at 3.3 and 4.9 mS treatments (Appendix V, Table 2, page 36).

These high levels of nutrients and consequently conductivity would probably account for the leaf scorch visible on the cultivars Aruba and Maui. However, the other cultivars although less vigorous were not showing scorch symptoms.

3.3 AFTER 9 WEEKS GROWTH

Flowering score, bud score, plant height and plant quality were recorded after 9 weeks. Treatment comparison of the main nutrient treatments 0.9, 1.7, 3.3 and 4.9 mS are shown as colour plates 1-6 in Appendix VII on pages 39 to 44.

3.3.1 Flower Score

Aruba, Barbados and Maui had greater mean flowering scores than the cultivars Anaea, Dorte and Vulcain (Table 3).

Table 3 Mean flower score for each cultivar at marketing

	Cultivar					
	Anaea	**Aruba**	**Barbados**	**Dorte**	**Maui**	**Vulcain**
Mean Flower Score	1.5	2.1	2.4	1.7	2.2	1.7

(P = <0.001)

There were some effects of nutritional treatments on flowering in the later stages of growth (Table 4).

Table 4 Effect of nutrient regimes on mean flowering score

	Treatments (weeks 6-9)			
Treatments (weeks 3-6)	**0.9**	**1.7**	**3.3**	**4.9**
0.9 mS	1.8	1.7	2.1	1.8
1.7 mS	1.5	2.0	1.7	2.2
3.3 mS	2.2	2.0	1.8	1.7
4.9 mS	1.7	2.2	1.9	2.1

(P = <0.021)

The worst flowering score was where plants were grown at 1.7 mS for the first 3 weeks then transferred to 0.9 mS nutrient treatment. The best flowering scores were where plants had been grown for the first 3 weeks at 1.7, 3.3 or 4.9 mS and then transferred to 4.9, 0.9 and 1.7 mS respectively.

3.3.2 Bud Score

The mean bud score was affected by cultivar. Dorte and Aruba had the largest scores, whilst Anaea and Maui had the smallest (Table 5).

Table 5 **Bud Scores for each variety at marketing**

	Anaea	Aruba	Barbados	Dorte	Maui	Vulcain
Mean Bud Score	3.1	3.9	3.4	4.0	3.0	3.6

(P = <0.001)

There were no effects of nutritional treatments on mean bud score at marketing (Table 6).

Table 6 **Effect of nutrient regime of mean bud score at marketing**

	Treatment			
Cultivar	**0.9mS**	**1.7mS**	**3.3mS**	**4.9mS**
Anaea	3.1	3.1	3.2	3.0
Aruba	3.9	4.0	4.0	3.7
Barbados	3.2	3.4	3.4	3.1
Dorte	4.0	4.0	4.0	4.0
Maui	3.0	3.2	3.0	3.0
Vulcain	3.6	3.6	3.6	3.3
Mean	3.5	3.5	3.5	3.3

N/S

3.3.3 Plant Height

There was little difference in the mean heights of Vulcain, Anaea and Dorte. These varieties were shorter than Maui, Aruba and Barbados (Table 7).

Table 7 Plant height at marketing for each cultivar

	Cultivar					
	Anaea	**Aruba**	**Barbados**	**Dorte**	**Maui**	**Vulcain**
Mean plant height (cm)	15.4	17.6	18.4	15.0	19.2	14.7

(P = <0.001)

Plants grown at 0.9 and 1.7 mS were on average taller than those grown at 3.3 or 4.9 mS (Table 8). Anaea appeared to be affected less by nutrition in contrast to the other varieties. The heights of Aruba, Maui and Vulcain were significantly reduced at 4.9 mS.

Table 8 Effect of nutrient regime on final plant height (cm) at marketing

	Treatment			
Cultivar	**0.9mS**	**1.7mS**	**3.3mS**	**4.9mS**
Anaea	14.9	15.7	15.2	15.7
Aruba	18.1	19.8	16.7	15.6
Barbados	18.6	19.9	17.7	17.5
Dorte	15.4	16.4	14.0	14.1
Maui	20.3	19.4	19.1	17.9
Vulcain	15.8	15.7	14.0	13.5
Mean	17.2	17.8	16.1	15.7

(P = <0.015)

3.3.4 Plant Quality

Barbados, Dorte and Vulcain had slightly higher quality scores than Anaea and Maui (Table 9).

Table 9 **Effect of nutrient regime on final plant quality at marketing**

	Treatment				
Cultivar	**0.9mS**	**1.7mS**	**3.3mS**	**4.9mS**	**Mean**
Anaea	1.7	1.6	1.1	0.5	1.2
Aruba	1.6	1.5	1.6	0.8	1.4
Barbados	1.8	1.9	1.9	1.8	1.8
Dorte	1.8	1.9	1.5	1.6	1.7
Maui	1.4	1.7	1.2	0.5	1.2
Vulcain	1.9	1.9	1.5	1.0	1.6
Mean	1.7	1.7	1.5	1.0	

(P = <0.001)

Plants grown at 4.9 mS during either their final 3 or 6 weeks were of much poorer quality (Table 10).

Table 10 **Effect of nutritional regime on plant quality at marketing**

	Treatment weeks 4-6	**Treatment weeks 7-9**
0.9 mS	1.5	1.7
1.7 mS	1.7	1.7
3.3 mS	1.5	1.5
4.9	1.2	1.0

(P = <0.002)

Overall plant quality was reduced at 3.3 and 4.9 mS due to smaller plant size and puckering of leaves. The varieties Aruba and Maui suffered particularly from leaf scorch at the highest nutrient regime.

3.3.5 Plant Growth

At the end of 9 weeks there were striking differences in plant growth and habit. At the lowest nutrient treatment, 0.9 mS, foliage colour was much paler and in general plant size was smaller in comparison to plants grown in treatment 1.7 mS, especially for Barbados and Dorte. At the higher nutrient treatments, 3.3 and 4.9 mS, plant habit was more compact, with much darker foliage which tended to become puckered in appearance. Severe leaf scorch was visible on Aruba and Maui at 4.9 mS. All other varieties appeared 'stunted' but with no visible scorch symptoms.

The leaf variegation on Vulcain was less visible at 0.3 or 4.9 mS.

There were no obvious differences in flowering between nutritional treatments at marketing, although flower size was reduced at 3.3 and 4.9 mS and flower colour was much paler in Barbados and Maui at these higher nutrient levels.

3.3.6 Growing Media Analyses

Media analysis at the end of 9 weeks revealed large differences in nutrient levels. At 3.3 and 4.9 mS, analysis showed that the levels of nitrate (as nitrogen) and especially potassium were much higher in comparison to the lower conductivity treatments. At 4.9 mS, media analysis showed a level of 1200 mg/l potassium (Appendix V, table 3, page 37).

Media analysis was also taken to show the nutritional status of the transfer treatments whereby for the first 3 or 6 weeks plants were held in a low or high nutrient treatment then moved to a high or low nutrient treatment. The results of their media analyses are also given in Appendix V, table 3, page **. These results show the strong differences which were observed between treatments, and the effect of switching from a high to a low feed or the reciprocal had on the nutritional status of the growing media.

3.4 Effect of photoperiod on flowering

Records of flowering score were taken 3, 6 and 9 weeks (marketing stage) after potting. The results are presented in graphical form in figure 1, Appendix, page 45.

There were some differences between cultivars; Barbados, Maui and Dorte generally having a higher flowering score whilst Vulcain and Anaea had a lower flowering score.

'Long' days promoted flowering in the varieties Barbados and Maui, and to a lesser extent in Dorte, Anaea and Vulcain. Aruba showed little difference in flowering between 'short' day and 'long' day treatments.

3.5 Shelf-life

Plants which reached marketing stage and were of good enough quality were subjected to a 3 week shelf-life assessment.

There were no consistent effects of the treatments on subsequent shelf-life performance and therefore detailed results have not been presented here. However, a number of general trends were evident.

Plants grown at higher nutrient regimes during the last 3-6 weeks suffered from greater bud drop and flower loss. This occurred very quickly after entering shelf-life. Plants grown at lower feed levels held both their flowers and buds well and continued to flower.

B. COMMERCIAL TRIALLING - POT PLANTS

The aim of the trials at the four main grower sites was to examine the effect of different cultural practices on the flowering of a range of cultivars. The results are shown in detail in Table 1, Appendix IX, page 46.

With the exception of the cultivar Largo, there were no consistent differences between sites. Each cultivar had a similar flowering score at each site, indicating that flowering is not strongly affected by individual cultural practices.

The results from the trial at Raceground Nursery, Spalding are shown in Table 2, Appendix IX, page 47. The cultivars Gardia, Heidelberg and Imperia recorded the highest flowering score, Heidelberg being more compact than the other two cultivars.

Overall, the cultivars chosen to have the better potential for commercial pot plant production were:

Gardia	Imola
Hanko	Imperia
Heidelberg	Ivrea

C. COMMERCIAL TRIALLING - BEDDING PLANTS

Thirty cultivars were trialled and evaluated at Springfields Garden to assess their performance and suitability as a bedding plant. The results from the assessments are given in Table 3, Appendix IX on page 48.

In summary, the following cultivars were thought to have the better outdoor performance:

Gardia	Adigio
Harlem	Motette
Heulva	Kanon
Imola	

4. DISCUSSION

Nutrition was seen to have a marked effect on plant growth. The treatment used within the trial were based on a standard liquid feed programme using increasing or decreasing dilution rates to provide the four main treatments based on conductivity (EC) levels. No attempts were made to equilibrate the N, P and K levels within the feeds. As such the results obtained cannot be solely attributed to differences in EC as the levels of N, P and K also varied. However, the results reflect closely observations made on other crops as a result of changes in EC level, and therefore do provide a very useful guide as to the effect of general nutrient levels on plant growth in New Guinea Impatiens.

Plants were more compact at the higher conductivity regimes, 3.3 and 4.9 mS. At these levels foliage colour was much darker and leaves became 'puckered'. The varieties Aruba and Maui suffered badly with leaf scorch at 4.9 mS. Vulcain and Barbados appeared to be able to withstand a greater range of nutrient concentrations.

A lower conductivity, 0.9-1.7 mS, caused more vegetative growth in the early stages, and foliage was paler at 0.9 mS treatment. Overall, a level of 1.7 mS produced the best quality plants, with good flower colour and size.

The nutrient regime did not significantly affect the flowering response in New Guinea. Even at very high levels, 4.9 mS, plots flowered in each variety. Therefore, although nutrition can play an important role in plant quality and growth, it does not appear to influence flower initiation or development. However, at high nutrient levels flower colour became much paler and flower size was reduced.

Differences in flowering scores were attributed to cultivar. Aruba and Dorte were much slower to reach flowering.

Changing the conductivity level from high/low or low/high did generate a rapid effect on plant growth. There was an indication that high nutrient levels (ECs) at the start of cropping aided plant height control and produced a more compact plant with an improved habit. During the early stages of growth soon after potting plant growth can be excessively vigorous/vegetative and the use of higher EC feeds could be advantageous in the control of plant height. High conductivities should not be extended for long periods as plant quality will be reduced. The conductivity level should be lowered to encourage flower development at marketing and to avoid high conductivity levels in shelf-life which were seen to be detrimental.

However, as a note of caution this experiment only evaluated a limited range of cultivars and under just one growing environment. Further research will be necessary to explore the potential use of nutrition to control plant growth. This experiment did show the 'varietal' response which can be obtained; Aruba and Maui suffering badly at high EC levels, whilst the other cultivars in the trial, although with a reduced vigour, did not show scorch symptoms.

Plants grown at high conductivity levels suffered greatly from flower and bud drop within 3-4 days of entering shelf-life. Plants grown at the lower nutrient regimes, 0.9 and 1.7 mS, had an improved shelf-life.

The effect of photoperiod is unclear due to the fact that photoperiod and light integral were confounded in this experiment. However, it appears that 'long' days or increased light integral were advantageous for flowering.

The commercial trials highlighted the differences which exist between cultivars and those best suited as a pot plant or as a bedding plant, or both. A summary is given below:

Best cultivars:	**pot plants**	**bedding plants**
	Gardia	Gardia
	Hanko	Harlem
	Heidelberg	Heulva
	Imola	Imola
	Imperia	Adigio
	Ivrea	Motette
		Kanon

5. CONCLUSION

Plants grown at an EC level not exceeding 1.7 mS produced the best plants overall. Higher nutrient regimes reduced plant vigour, and at concentrations greater than 3.3 mS severe leaf scorch and in some instances plant death occurred with the cultivars Aruba and Maui. Increasing the EC of the applied feed soon after potting can limit plant growth at a time of greatest plant vigour and vegetative growth. However, prolonged exposure to high EC levels will cause a loss in plant quality and poor shelf-life. It is recommended that EC levels are lowered towards marketing to ensure a low nutrient level during the marketing chain.

It appears that cultivars of New Guinea Impatiens can respond differently to the nutritional regime imposed. Generally plants were more tolerant of higher levels of nutrient than recorded in previous trials.

The choice of variety remains an important factor for the successful commercial production of New Guinea Impatiens. There are so many cultivars available on the market that commercial trialling is important to establish a smaller range which can be grown successfully as either a pot plant or bedding plant. Many of the new varieties show great potential as both.

- Nutrition has a marked effect on plant growth with increased conductivity causing more compact growth and at levels above 3.3 mS can cause severe leaf scorch or plant death.

- Nutrition has little effect on flower initiation or development, but high nutrient levels will reduce flower size and colour.

- Aruba and Maui are more sensitive to high nutrient levels in the growing media.

- Cultivars trialled were able to withstand irrigation with electrical conductivity up to 3.3 mS.

- High EC levels at marketing are detrimental to shelf-life performance.

- New cultivars are of better quality: more compact, floriferous and can be used successfully as both a pot plant and bedding plant.

APPENDICES

APPENDIX I

Nutrient solution analysis - mains water at HRI Efford, May 1994

Conductivity	$\mu s/20^{\circ}C$	490
pH		7.8
Nitrate (as N)		5.6
Ammonia (as N)		<0.1
Potassium		<0.1
Magnesium		2.3
Calcium		100.0
Phosphorus		0.1
Sodium		12.0
Chloride		22.0

APPENDIX II

Media analysis* at potting (VAPO BO + dolodust + limestone + fritted trace elements)

Conductivity	µs/20°C	7.2
pH		6.1
Nitrate (as N)	mg/l	13.1
Ammonium (as N)	mg/l	0.1
Potassium	mg/l	18
Calcium	mg/l	27
Magnesium	mg/l	3.6
Phosphorus	mg/l	2.4
Iron	mg/l	2.36
Zinc	mg/l	0.36
Manganese	mg/l	0.48
Copper	mg/l	0.06
Boron	mg/l	0.06

* water available extractable analysis

APPENDIX III

Analysis of applied liquid feeds for each treatment

		Target Conductivity			
		0.9mS	**1.7mS**	**3.3mS**	**4.9mS**
Conductivity	us/20⁰ C	908	1413	3365	4400
pH		6.5	6.5	6.2	6.4
Nitrate (as N)	mg/l	56	116	623	854
Ammonium (as N)	mg/l	1.4	5.7	73.7	114.7
Potassium	mg/l	123	260	656	900
Calcium	mg/l	101	88	97	99
Magnesium	mg/l	2	2	3	4
Phosphorus	mg/l	16	29	77	110
Iron	mg/l	<0.01	<0.01	<0.01	<0.01
Zinc	mg/l	<0.01	<0.01	0.02	0.02
Manganese	mg/l	<0.01	<0.01	<0.01	<0.01
Copper	mg/l	<0.01	<0.01	<0.01	<0.01
Boron	mg/l	0.03	0.01	0.02	0.02
Sodium	mg/l	14	14	16	16
Chloride	mg/l	25	26	33	32
Sulphate (as S)	mg/l	6	5	6	7

APPENDIX IV

Crop Diary

Plants were potted on 10 June.
Commenced nutrient treatments at potting, 10 June.
Intermediate plant spacing to 40/m² on 24 June.
Final plant spacing to 20/m² on 15 July.
Final plant growth (marketing) records taken on 12 August.

Pest and disease control measures

Biological control agents were introduced as follows:

on a weekly basis

Aphidius matricasiae	for	Aphids
Aphidoletes aphidomyza	for	Aphids
Encarsia formosa	for	Glasshouse Whitefly
Phytoseiulus persimilis	for	Red Spider Mite

every four weeks

Amblyseius cucumeris	for	Western Flower Thrips

No chemical pesticides were applied during the trial.

APPENDIX V

Table 1 **Media analysis* from the nutrient regimes after 3 weeks**

		0.9mS	1.7mS	3.3mS	4.9mS
Conductivity	μs/20^0 C	51	75	184	237
pH		6.3	6.2	6.0	6.1
Nitrate (as N)	mg/l	3	15	88	112
Ammonium (as N)	mg/l	0.4	0.8	9.1	21.4
Phosphorous	mg/l	1	2	16	17
Potassium	mg/l	18	42	162	217
Magnesium	mg/l	3	4	7	9
Calcium	mg/l	24	30	61	72
Sulphate (as S)	mg/l	7	6	7	10
Sodium	mg/l	12	18	18	24
Chloride	mg/l	12	38	22	33
Copper	mg/l	<0.10	<0.10	<0.10	<0.10
Manganese	mg/l	<0.10	<0.10	<0.10	<0.10
Iron	mg/l	0.66	0.48	0.36	0.48
Zinc	mg/l	0.01	<0.01	<0.01	<0.01
Boron	mg/l	0.24	<0.01	<0.01	<0.01
Bulk Density	g/l	0.219	0.203	0.247	0.230
Dry Matter Density	g/l	0.07	0.07	0.07	0.08
Dry Matter	%	19.07	21.51	19.19	20.61

* water available extractable analysis

APPENDIX V

Table 2 Media analysis* from the nutrient regimes after 6 weeks

		0.9mS	1.7mS	3.3mS	4.9mS	0.9-4.9mS[1]	4.9-0.9mS[1]	1.7-3.3mS[1]	3.3-1.7mS[1]
Conductivity	μs/20° C	69	104	662	835	749	346	749	343
pH		6.6	7.1	5.6	5.6	5.8	6.5	5.7	6.4
Nitrate (as N)	mg/l	6.0	22	414	518	472	164	375	175
Ammonium (as N)	mg/l	1.0	3.9	15.4	47.1	22.6	7.5	8.9	7.4
Potassium	mg/l	30	132	648	912	774	342	576	324
Calcium	mg/l	39	50	278	251	267	124	256	138
Magnesium	mg/l	4	4	34	32	36	16	34	19
Phosphorus	mg/l	2	8	60	90	47	26	37	24
Iron	mg/l	1.5	1.62	0.42	0.48	0.42	0.60	0.66	0.72
Zinc	mg/l	1.86	0.84	0.78	0.96	0.78	0.90	1.20	1.56
Manganese	mg/l	0.06	<0.01	0.48	0.54	0.36	0.18	0.30	0.18
Copper	mg/l	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Boron	mg/l	0.24	<0.01	<0.01	0.18	<0.01	<0.01	0.24	<0.01
Sodium	mg/l	78	72	72	60	84	78	96	78
Chloride	mg/l	70	96	93	91	117	81	102	107
Sulphate (as S)	mg/l	14	16	13	15	13	13	17	13
Bulk density	g/l	0.271	0.282	0.331	0.332	0.322	0.317	0.311	0.287

* = water available extractable analysis
[1] = plants transferred after 3 weeks from one nutrient regime to the next

APPENDIX V

Table 3 Media analysis* from the range of nutrient regimes at marketing (9 weeks)

		0.9mS	1.7mS	3.3mS	4.9mS	0.9 - 4.9mS[1]	0.9 - 4.9mS[2]	4.9 - 0.9mS[1]	4.9 - 0.9mS[2]	1.7 - 3.3mS[1]	1.7 - 3.3mS[2]	3.3 - 1.7mS[1]	3.3 - 1.7mS[2]
Conductivity	µs/20° C	68	154	824	938	740	594	195	677	762	557	288	550
pH		6.8	7.3	5.3	5.3	5.5	6.6	6.9	5.4	5.5	6.3	7.1	5.6
Nitrate (as N)	mg/l	1.0	20	537	604	473	359	80	440	497	326	115	350
Ammonium (as N)	mg/l	0.1	2.3	16.6	50.7	30.6	13.4	1.0	12.4	14.1	6.5	3.6	5.2
Potassium	mg/l	47	205	996	1200	972	811	224	809	913	731	371	632
Calcium	mg/l	39	44	284	232	166	136	70	221	263	142	83	200
Magnesium	mg/l	3	3	30	26	18	15	7	25	29	16	8	23
Phosphorus	mg/l	2	14	39	94	87	39	18	78	71	34	27	58
Iron	mg/l	1.20	1.58	0.27	0.21	0.25	0.48	0.81	0.20	0.35	0.90	0.80	0.29
Zinc	mg/l	0.32	0.67	0.82	1.00	0.64	0.27	0.40	0.88	1.07	0.38	0.37	0.87
Manganese	mg/l	0.03	0.11	0.56	0.53	0.34	0.09	0.09	0.49	0.38	0.15	0.09	0.39
Copper	mg/l	0.11	0.11	0.07	0.08	0.04	0.07	0.10	0.05	0.06	0.08	0.08	0.09
Boron	mg/l	0.54	0.13	0.13	0.10	0.08	0.35	0.04	0.24	0.07	0.34	0.02	0.21
Sodium	mg/l	42	54	54	48	42	66	48	48	54	0.78	66	42
Chloride	mg/l	18	66	90	90	78	66	42	78	84	102	84	72
Sulphate (as S)	mg/l	9	11	8	9	6	11	7	9	8	12	9	7
Bulk density	g/l	0.379	0.364	0.450	0.420	0.384	0.433	0.352	0.346	0.448	0.456	0.410	0.353

* = water available extractable analysis
[1] = plants transferred after 3 weeks from one nutrient regime to the next
[2] = plants transferred after 6 weeks from one nutrient regime to the next

APPENDIX VI: RESULTS AT 6 WEEKS

Table 1 **Effect of nutrient regime on mean flower score after 6 weeks**

Cultivar	Treatment 0.9mS	1.7mS	3.3mS	4.9mS	Mean
Anaea	1.75	1.80	0.96	0.73	1.27
Aruba	0.50	0.26	0.20	0.46	0.36
Barbados	2.12	0.98	1.43	1.45	1.50
Dorte	0.44	0.71	1.05	0.58	0.70
Maui	1.54	1.64	1.58	2.06	1.70
Vulcain	1.18	1.50	1.67	1.36	1.43
Mean	1.23	1.15	1.15	1.11	

(P = <0.001, SED = 0.2995, d.f. = 15)

Table 2 **Effect of nutrient regime on mean bud score after 6 weeks**

Cultivar	Treatment 0.9mS	1.7mS	3.3mS	4.9mS	Mean
Anaea	1.46	1.89	1.83	1.74	1.73
Aruba	2.62	2.70	2.26	2.70	2.57
Barbados	2.08	2.17	2.26	2.24	2.19
Dorte	3.20	3.15	3.53	3.50	3.35
Maui	1.97	2.33	2.06	2.36	2.18
Vulcain	2.48	2.50	2.30	2.27	2.38
Mean	2.30	2.46	2.37	2.47	

(NS)

APPENDIX VII

Plate 1 Treatment comparison of the cultivar Anaea at 9 weeks

Treatment

0.9mS

1.7mS

3.3mS

4.9mS

APPENDIX VII

Plate 2 Treatment comparison of the cultivar Aruba at 9 weeks

Treatment

0.9mS

1.7mS

3.3mS

4.9mS

APPENDIX VII

Plate 3 Treatment comparison of the cultivar Barbados at 9 weeks

Treatment

0.9mS

1.7mS

3.3mS

4.9mS

APPENDIX VII

Plate 4 Treatment comparison of the cultivar Dorte at 9 weeks

Treatment

0.9mS

1.7mS

3.3mS

4.9mS

APPENDIX VII

Plate 5 **Treatment comparison of the cultivar Maui at 9 weeks**

Treatment

0.9mS

1.7mS

3.3mS

4.9mS

APPENDIX VII

Plate 6 Treatment comparison of the cultivar Vulcain at 9 weeks

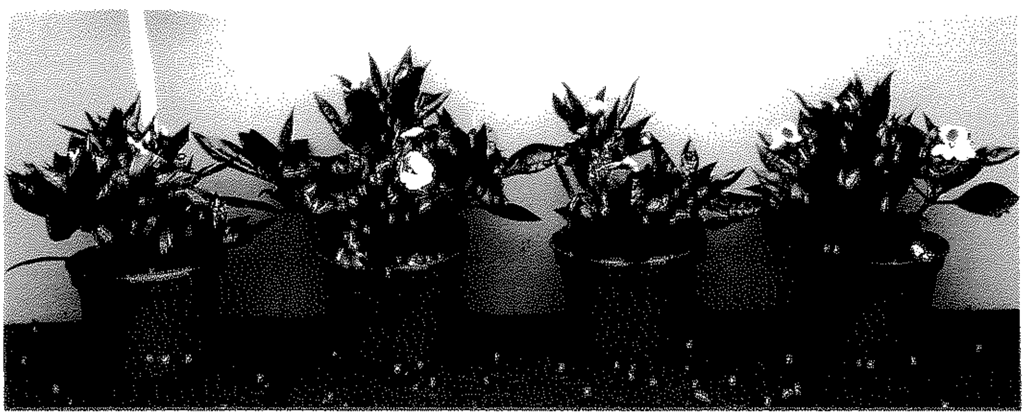
Treatment

0.9mS

1.7mS

3.3mS

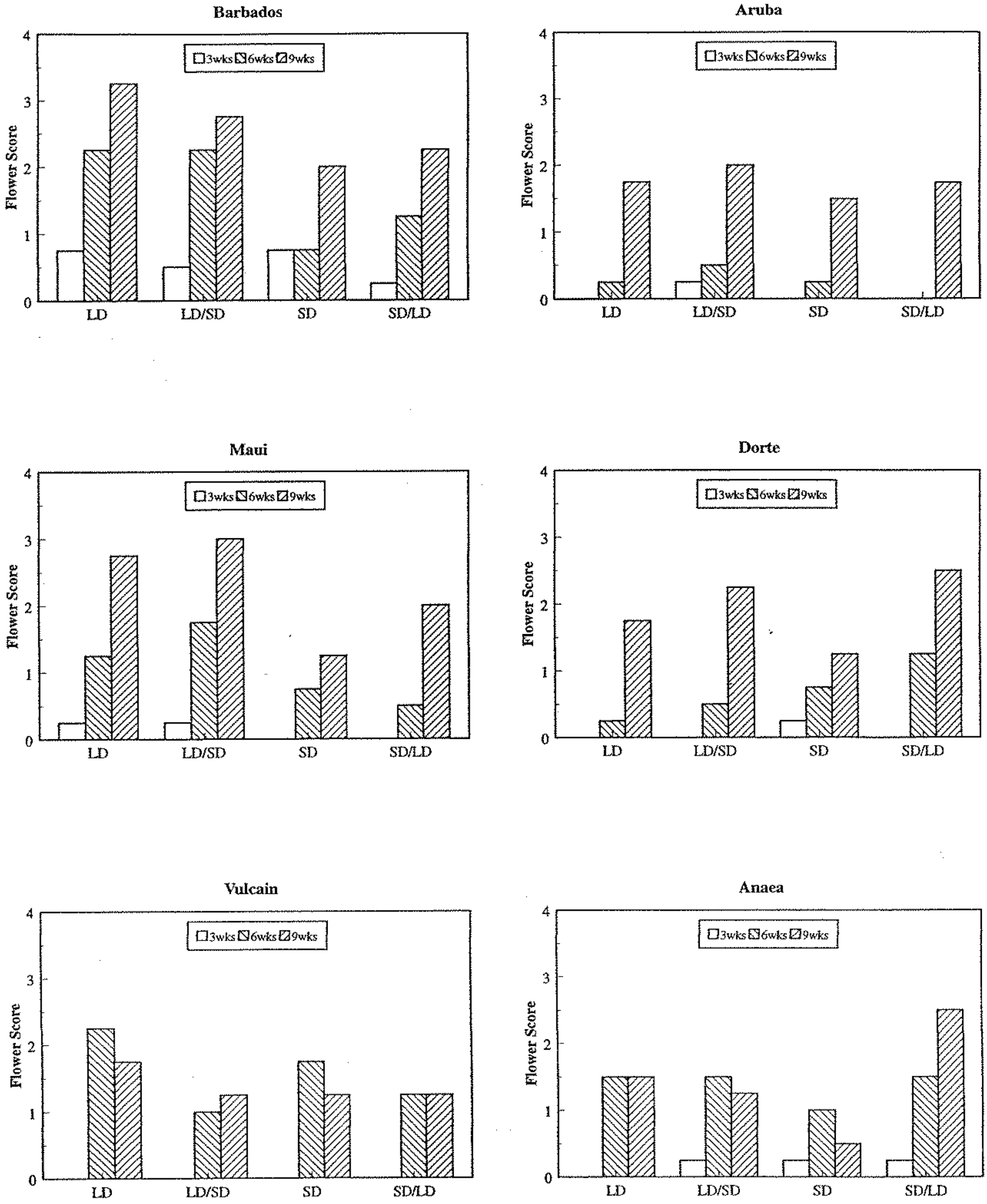
4.9mS



APPENDIX VIII

New Guinea Impatiens: Effect of Photoperiod upon Flowering

Figure 1



LD=long days
SD=short days
LD/SD=4wks long days/4wks short days
SD/LD=4wks short days/4wks long days

Flower Score:
0=zero, 1=1-2, 2=3-5, 3=6-10, 4=10+

APPENDIX IX: COMMERCIAL TRIALS: POT PLANTS

Table 1 Flower score results at each different grower site at marketing

Cultivar	Nursery				Comments
	A	B	C	D	
Allegro	5	4	5	5	Uniform growth but flowers held in foliage
Anaea	1	2	1	1	Compact; flowers held in foliage
Barbados	3	4	3	3	Upright habit, long internodes, flowers prominent
Concerto	5	4	4	4	Compact habit, flowers prominent
Dorte	1	2	2	1	Very short, flowers held in foliage
Lanai	-	3	1	1	Compact, flowers held in foliage
Largo	5	2	5	2	Compact, flowers prominent
Selenia	1	-	0	0	Compact, flowers held in foliage
Viola	1	-	2	1	Uniform and vigorous, flowers held in foliage
Vivace	3	2	2	1	Compact, flowers prominent
Vulcain	3	2	3	2	Vigorous and upright growth, flowers prominent

Flower Score : 0 - 5, 5 = full flower
- : cultivar not on trial at that site
A : Danecroft Nursery
B : Europa Nursery
C : Double H Nurseries
D : Ivanda Nurseries

APPENDIX IX COMMERCIAL TRIALS: POT PLANTS

Table 2 Results of trials at Raceground Nursery at marketing

Cultivar	Flower Colour	Flower Score	Plant Height (cm)	Leaf Colour	Vigour Score	Comments
Gardia	Salmon/pink	4	20	dark green	5	few flowers only buds on score date
Hagi	Rose with red centre	2	16	light green	4	few flowers, many buds
Hailum	Light pink	2	11	dark green	2	flower held low not prominent
Hanko	Orange/red	2	17	light green	5	compact flowers not prominent
Harlem	Cerise/pink	1	18	light green	3	vigorous flowers held well
Heidelberg	Rose/mauve	4	15	dark green	4	flower not prominent
Helsinki	Light mauve	1	19	light green	5	compact, flowers prominent
Hong Kong	Mauve	0	12	light green	2	few flowers not prominent
Hudson	Salmon/pink	1	18	light green	5	no flowers at scoring
Heulva	Pink redeye	0	19	medium green	5	few flowers not prominent
Husum	Salmon /orange	1	17	dark green	4	few flowers only buds on score date
Imola	Orange	3	16	light green	4	flowers held in foliage
Imperia	Scarlet Red	4	18	light green	4	flowers prominent
Ivrea	Cream/white	3	13	light green	2	vigorous flowers prominent
Izmir	Orange	2	18	light green	5	small compact flowers prominent
Kairo	Deep pink, light pink reflex	-	13	dark green	3	vigorous
Kampala	Mauve/purple	2	12	light green	3	compact, few flowers

Vigour Score : 0 very poor, 5 very vigorous
Flower Score : 0 no flowers, 5 = flower cover

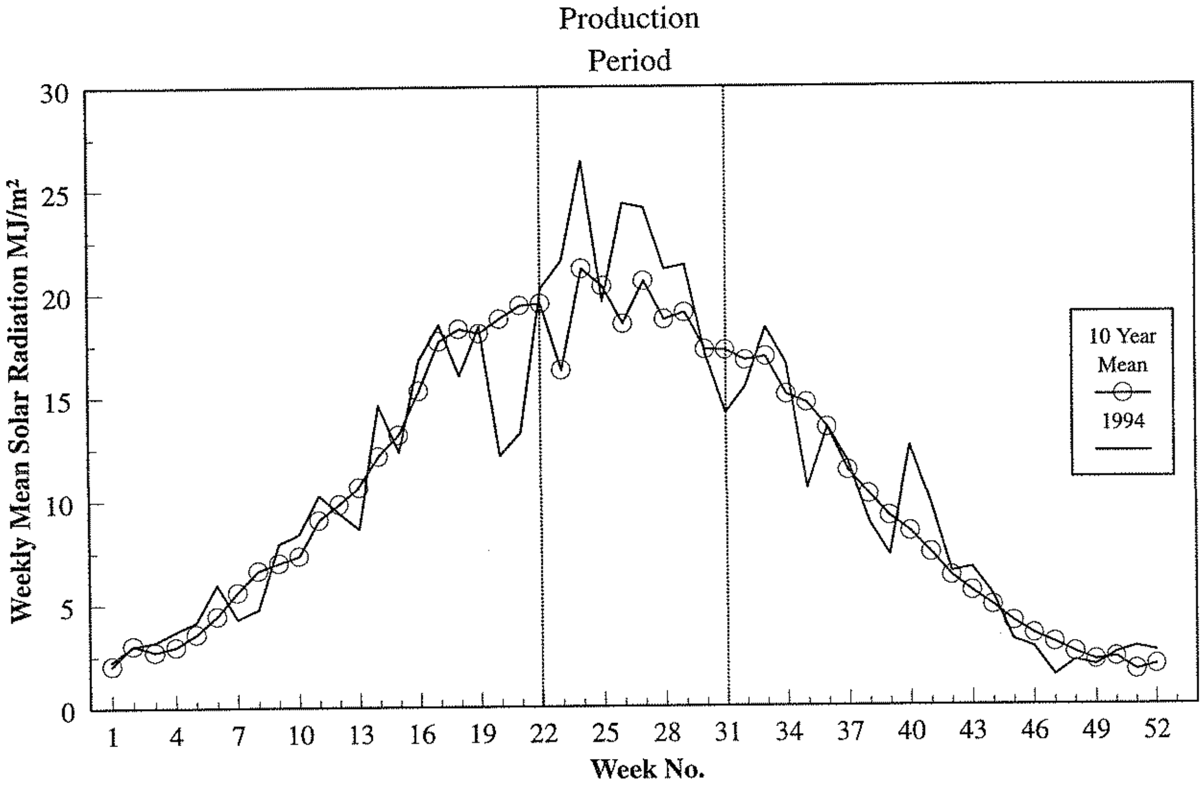
APPENDIX IX COMMERCIAL TRIALS: BEDDING PLANTS

Table 3 Results of bedding out trials at Raceground Nursery at Springfield Gardens

Cultivar	Colour	Flower Cover	Height (cm)	Leaf Colour	Vigour	Comments
Gardia	Salmon/Pink	3	23	dark green	5	Vigorous good shape
Hagi	Rose with red	3	19	light green	3	
Hailum	Light Pink	2	14	dark green	2	Slow growing
Hanko	Orange/Red	3	14	light green	3	
Harlem	Cerise/Pink	3	20	light green	4	
Heidelberg	Rose/Mauve	3	23	dark green	5	
Helsinki	Mauve	1	25	medium green	5	Very vigorous, few flowers at scoring
Hong Kong	Mauve	4	17	light green	3	Lacks vigour
Hudson	Salmon/Pink	3	20	light green	4	
Heulva	Pink red eye	4	24	medium green	5	Good shape and flower cover
Husum	Salmon/Orange	3	18	dark green	3	Good shape, flower held in foliage and fade
Imola	Orange	4	18	light green	3	Compact good flower cover
Imperia	Scarlet	3	26	light green	3	Long internodes
Ivrea	Cream/White	1	15	light green	1	Has not got away under dry conditions
Izmir	Orange	2	17	light green	3	Upright few flowers
Kairo	Deep Pink	2	23	dark green	5	Few flowers
Kampala	Mauve	3	16	light green	2	Small has not grown in a dry summer
Adigio	Cerise	4	23	light green	5	
Allegro	Cerise	2	15	light green	2	
Bourree	Orange	2	17	light green	3	Flowers fading
Cambo	Pink/mauve	2	18	light green	4	
Concerto	Blush pink	3	14	light green	2	
Glissando	White	4	18	light green	3	
Harmonie	Blush pink/white	2	18	light green	5	Very vigorous
Kanon	Cerise/Mauve	4	17		3	
Motette	Red	3	24	light green	4	
Opera	Cerise	3	23	light green	3	Flowers fade, habit long internodes
Sarabunde	Lilac/cerise pink stripe	4	24		5	Very vigorous
Sinfoine	Pink	3	15	light green	2	Compact
Sonate	Cerise	3	19	light green	3	

Score: Flower cover - 0 no flowers, 5 full cover
Vigour - 0 very poor, little growth, 5 very vigorous good shape

APPENDIX X SOLAR RADIATION AT HRI EFFORD, 1994



APPENDIX XI COPY OF CONTRACT, TERMS AND CONDITIONS

Contract between HRI & ADAS (hereinafter called the "Contractors") and the Horticultural Development Council (hereinafter called the "Council") for research/development project.

1. **TITLE OF PROJECT**

Contract No: PC80a
Contract date: 14.3.94

NEW GUINEA IMPATIENS: EXTENDING THE GROWING SEASON AND IMPROVING PLANT PRODUCTION AND SHELF LIFE USING CULTURAL AND CHEMICAL MEANS

2. **BACKGROUND AND COMMERCIAL OBJECTIVE**

The production of New Guinea Impatiens is generally limited to the summer months since problems of bud opening/bud drop have been experienced when grown under poor light. However, with the introduction of a range of new varieties and the potential of the crop as a pot plant, further aspects of its culture need to be examined and schedules produced for cropping at different times of the year. The first trial in 1993 at HRI Efford under project PC80 showed little benefit from the use of supplementary lighting on plant growth in terms of quality and production time when grown at a standard temperature of 18°C, nor were any problems encountered relative to bud drop under shelf life conditions in this trial. Consequently the crop would appear to have greater potential for out of season production than hitherto envisaged. The trial highlighted some areas requiring further work: Varietal performance relative to vigour of growth and production time, pot size and spacing required for different markets and management for targeting sales at different times of the year need following up. Very little work has been carried out on New Guineas worldwide but a literature search revealed that flowering may be affected by a combination of temperature and light (Simmons 1982). Simmons showed that at 15°C the time taken for flower initiation is greatly reduced but the rate of flower development is greater at 25°C with a strong response to photoperiod. His work also confirmed that at 18°C supplementary lighting has little effect on plant development.

The scope of work in this project would concentrate on out of season production over the winter period but starting earlier than 1993 in Week 1 to target the Easter markets. The varietal response to the cultural treatments would also need to be examined and a range of cultivars selected by growers as potential performers for the future would be used. A second trial drawing on the data from the January trial and the 1993 work would allow more further examination of more promising treatments to be followed up in conjunction with other cultural factors more applicable for summer bedding production.

The crop must be carried through to assess treatment affects on post harvest properties of the plants and to provide confirmation of shelf life and/or not of flower 'sticking' needs. Whether bud drop could be associated with nutrition rather than light needs investigating.

3. POTENTIAL FINANCIAL BENEFIT TO THE INDUSTRY

Improved quality of final plant giving better shelf life for retailing and home environment. Economic assessments would be made to compare treatments and schedules. A greater understanding of the cultural requirements for successful early season production of New Guineas.

Additional benefits may occur in reduction of labour use both in production and harvesting whilst maintaining quality standards of UK product.

4. SCIENTIFIC/TECHNICAL TARGET OF THE WORK

To assess the response of a range of varieties to cultural and chemical treatments in early season New Guinea Impatiens production.

5. CLOSELY RELATED WORK - COMPLETED OR IN PROGRESS

HRI Efford: PC80 using supplementary lighting and anti-ethylene compounds to improve shelf-life of pot plants.

PC80 second trial and observation trials carried out at Lee Valley EHS (Farthing 1984) and at HRI Efford (Sapsed 1990) showed that effects of Alar and Bonzi on New Guinea Impatiens appeared to vary with variety.

Simmons 1982 showed that temperature in combination with light affects flower initiation and subsequent development of New Guinea Impatiens. This needs testing under UK conditions.

6. DESCRIPTION OF THE WORK

Trial 1. To start January 1994.

Cultivars	-	Anaea	Saturina
		Delias	Samoa
		Maui	Antigua
		Aruba	Bolero
		Blue	Lindyhop
		Cha Cha	Danbee
		Dunya	Eurema
		Selenia	Vulcan

These cultivars have been selected with reference to the 1993 trials and individual New Guinea Impatiens grower's experience to include types which cover a range of flower and foliage colours, from both the Paradise and Classic series, show potential in terms of plant quality but are difficult to flower uniformly and hence grow economically.

Treatments -

Temperature/lighting treatments

i. 25°C with 2500 lux supplementary lighting for 12 hours
ii. 20°C with 2500 lux supplementary lighting for 12 hours
iii. 15°C with 2500 lux supplementary lighting for 12 hours
iv. 20°C without lighting

Shelf-life treatments:

All plants given a simulated market run prior to shelf-life of 3 weeks.

Design:

Unreplicated trial with the main plots of temperature and lighting in 4 ebb and flow floor compartments in K-block.

Blocks of each variety within the compartments will be in the same geographic location. Each varietal block will consist of 2 x 20 plants/compartment.

Culture: To be grown in 10 cm pots.
4°C DIF drop for 2 hours from sunrise/Standard PGR regime should growth control appear necessary.
Routine IPM programme for pest and disease control.

Records:

1. Crop diary
2. P & D assessments plus physiological damage to foliage/flower development
3. Time to 50% flowering
4. Harvesting: Final growth and quality assessments
5. Shelf-life and transportation damage assessment
6. Photographs at all stages as appropriate

Trial 2. To start April 1994

This trial would draw on data from the January trial and the 1993 trials allowing for more promising treatments to be followed up. Lighting would be less applicable at this time of year but the temperature/light relationship may well be better understood so that it can be incorporated with other cultural factors such as shading, nutrition, growth regulation and plant densities.

'Shelf-life' will be assessed by bedding out observations.