Stockbridge House, Cawood, Selby, North Yorkshire

FINAL PROJECT REPORT

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Cucumbers: Plant Establishment & Nutrition

PC 124

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Project title:	Cucumbers: Plant Establishment and Nutrition
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The results and conclusions in this report are based on a series of three experiments. The conditions under which the experiments were carried out and the results have been reported with detail and accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results especially if they are used as the basis for commercial product recommendations.

Authentication

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

Signature ....

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CONTENTS

Page No.

PRACTICAL SECTION FOR GROWERS

Background and objectives 1

Summary of results 1

Action points for growers 3

Practical and financial benefits from the study 3

SCIENCE SECTION

Introduction 4

Objectives 5

Experiments 1 & 2: To determine the effect of nitrate content of the applied hydroponic feed and transplant age on establishment of rockwool growth cucumbers.

Materials and Methods 6

Results

1. Effect of nitrogen concentration of applied hydroponic feed on plant establishment 7

2. Effect of transplant age on plant establishment 14

Experiment 3: Effect of shading and irrigation regime on plant establishment.

Materials and Methods 20

Results 21

Discussion 25

Conclusion 27

Appendix 1a: Nitrogen levels of the drip, slab and run-off solution for the winter crop. 29

Appendix 1b: Nitrogen levels of the drip, slab and run-off solution for the summer crop. 30

PRACTICAL SECTION FOR GROWERS

Background and objectives

It has been demonstrated (HDC project PC 111) that nitrate levels in the feed applied to cucumbers can be reduced for mature plants that are producing fruit, giving savings in fertiliser costs and reducing the risk of nitrogen run-off into ground water. However, during the establishment phase the plant has a much higher demand for nitrogen.

This project aimed to determine the optimum nitrogen concentration of the applied feed during the establishment phase and the effects of transplant age on growth and productivity of winter and summer crops. The use of high volume irrigation combined with shading the crop was also investigated as a possible means to improve plant establishment in a summer replant crop.

Summary of results

Three short experiments were carried out over the season using a winter and two summer replant crops

Applied nitrogen

A winter crop and a summer replant crop were irrigated, from initial wetting up, with nutrient solutions containing 100 ppm, 150 ppm, 200 ppm and 250 ppm nitrogen (N). Regular solution analysis of the slab and run-off indicated that early in the growth of the plants there was a high demand for nitrogen.

Plant growth rates and vigour were reduced in plants fed at the lowest N concentrations. The vigour of the first lateral shoot was also reduced at the lowest N concentration. These effects were more pronounced in the winter crop.

Total yield during the early stages of harvesting was reduced in both winter and summer crops with plants fed at 100ppm applied nitrogen, yields were greatest at 150 ppm and 200 ppm. Fruit quality was also reduced at the low levels of applied nitrogen (100 and 150ppm) in the winter crop.

Transplant age

Older transplants had increased growth rates in both the winter and summer crops, however the effect was less pronounced in the summer crop and the young transplants effectively caught up during the second week after transplanting.

Yields were significantly higher from older transplants in both the winter and summer replant crops. Although transplant age did not affect fruit quality in the summer replant crop there was a suggestion that the older transplants in the winter crop produced slightly less Class I fruit.

Crop shading and irrigation regime

In this trial crop shading and the use of high volume irrigation had no significant effect on plant establishment, crop productivity or fruit quality compared to the standard irrigation and husbandry practices for a summer replant crop, probably due to cool and dull weather conditions after planting.

Action points for growers

The target nitrogen concentration of the applied feed for cucumbers during the establishment phase and whilst harvesting stem fruit should be 200 ppm. This can be reduced to 150 ppm on mature plants when first lateral growth is well developed (PC 111).

Use older rather than younger transplants in order to attain earlier harvests and higher yields'

30 days was better than 26 days in winter.

21 days was better than 18 days in summer.

Practical and financial benefits from the study

Use of sufficient nitrogen in the early stages of growth will ensure that a strong plant is established and production of early high value fruit is maximised.

The study provides clear guidance on how long the level should be maintained and when it can be reduced to minimise nitrate run-off.

Although older plants may be more expensive the study demonstrates the value of planting a more advanced plant.

The project also demonstrates that the use of irrigation to improve plant establishment in summer may only be beneficial in some circumstances. Water is expensive and should not be wasted but liberal applications may be of benefit where temperatures are very extreme. This experiment was unable to validate the technique.

Shading can have more effect than irrigation on root temperature but may make plants etiolate.

SCIENCE SECTION

Introduction

The period directly after planting rockwool grown cucumbers is vital for the establishment of a successful crop. Factors such as plant size, root temperature and irrigation regime are all likely to affect rooting into the substrate and subsequent growth and productivity.

The current practices of replanting cucumbers two or sometimes three times during the season has made this aspect of crop management increasingly important.

Recent HDC funded work at HRI Stockbridge House (PC 111 Cucumbers: The effect of reduced nitrate input on yield and quality) has shown that cucumbers can be grown on rockwool at significantly lower levels of applied nitrogen than is currently the practice. Recommendations have been made to reduce concentrations to 150 ppm once the crop is in full production but the work indicated that higher levels are required during establishment and early growth. Young cucumber plants have a high demand for nitrogen which seems to fall when fruit production begins.

There is a need to establish the nitrogen requirement of young cucumber crops and to determine at what stage concentrations can be reduced to main season levels.

This trial was set up to consider both nitrogen nutrition and plant establishment. Three short trials were conducted. The first two investigated the effect of nitrogen nutrition and transplant age on the winter and summer replant crop. The final trial was set up to investigate the effect of irrigation regime and shading on plant establishment.

Objectives

To determine the optimum nitrogen concentration of applied feed during the establishment phase of the crop and how long it should be applied.

To investigate the effect of transplant age on early plant yield.

To determine if the irrigation regime influences plant establishment in summer crops.

EXPERIMENTS 1 & 2: To determine the effect of nitrate content of the applied hydroponic feed and transplant age on establishment of rockwool grown cucumbers.

Materials and Methods

Cultural details

Winter		Summer	
Sowing dates		Sowing dates	
30 day old	16 December	21 day old	13 May
26 day old	20 December	18 day old	16 May
Planting date	15 January	Planting date	3 June
Date of 1st pick	10 February	Date of 1st pick	20 June
End of trial	30 April	End of trial	8 August

Treatments

	Winter	Summer
Transplant age	30 days	21 days
	26 days	18 days
Varieties	Jessica	Jessica
	Pyralis	Enigma
Nitrogen applied feed	100 ppm	100 ppm
	150 ppm	150 ppm
	200 ppm	200 ppm
	250 ppm	250 ppm

Experiment design

Each plot consisted of six rockwool slabs with 2 plants per slab. Plant spacing was 1.6m x 0.45m. Treatments comprised of all combinations of two varieties, two transplant ages and four nitrogen concentrations in the applied feed. The treatments were arranged as randomised blocks replicated three times.

Records and assessments

Yield (kgm^{-2}) and quality (Class I and II).
Weekly plant height (cm).
Weekly plant vigour score (0-5, where 5 = best).
Leaf number, vigour and height at planting.
Weekly nutrient analysis of drip slab and run off solutions.

Results

1. Effect of nitrogen concentration of applied hydroponic feed on plant establishment

Growth rates

Mean daily growth rates increased with time from transplanting. Growth rates in the winter crop were reduced by approximately 2 cm day^{-1} compared with the summer crop this was probably due to the latter growing in high light conditions.
The different rates of applied nitrogen had no effect on the rate of plant growth in either the winter or summer crops up to 14 days after planting (Figure 1). The summer crop reached the wire shortly after this date and the plants were stopped. The winter crop grew much more slowly and did not reach the wire until more than 21 days after transplanting. By this stage feeding at 100 ppm nitrogen had reduced the mean daily rate of plant growth (Figure 1).

Plant vigour assessments

Plants fed with 100 ppm nitrogen exhibited reduced overall plant vigour and this was especially noticeable in the winter crop (Figure 2). As expected the summer crop was more vigorous once it had established. The fall in vigour recorded 7 days after transplanting for all treatments can be attributed to the high temperatures and insufficient rooting into the rockwool slabs (Figure 2).

Figure 1 Effect of applied nitrogen (ppm) in the hydroponic feed on daily growth rates of a winter and summer replant cucumber crop.

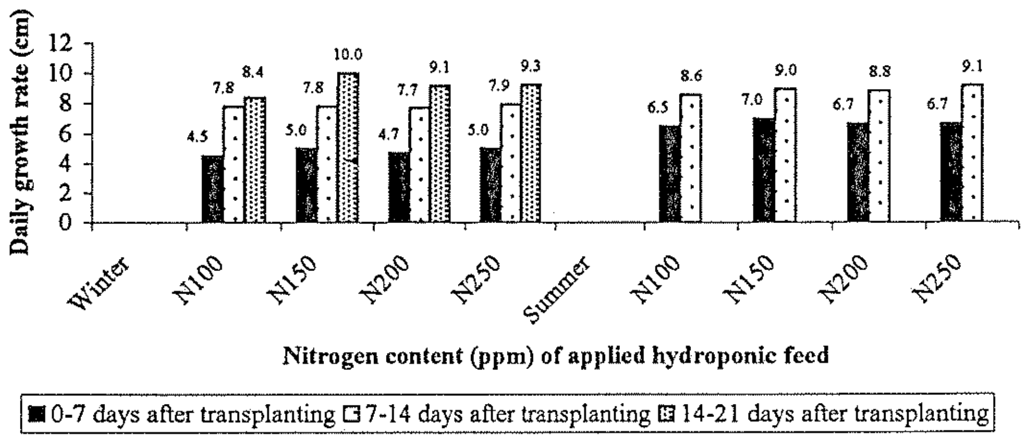


Figure 2a. Effect of nitrogen (ppm) content of the applied feed on overall plant vigour of a winter cucumber crop.

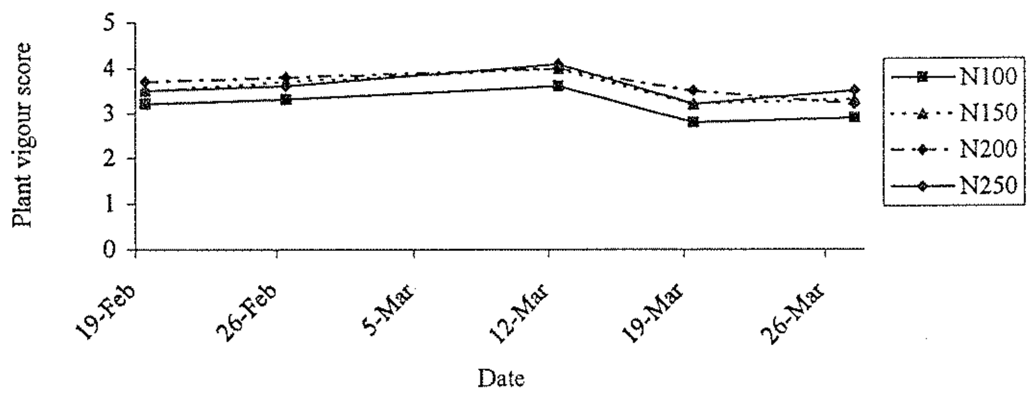
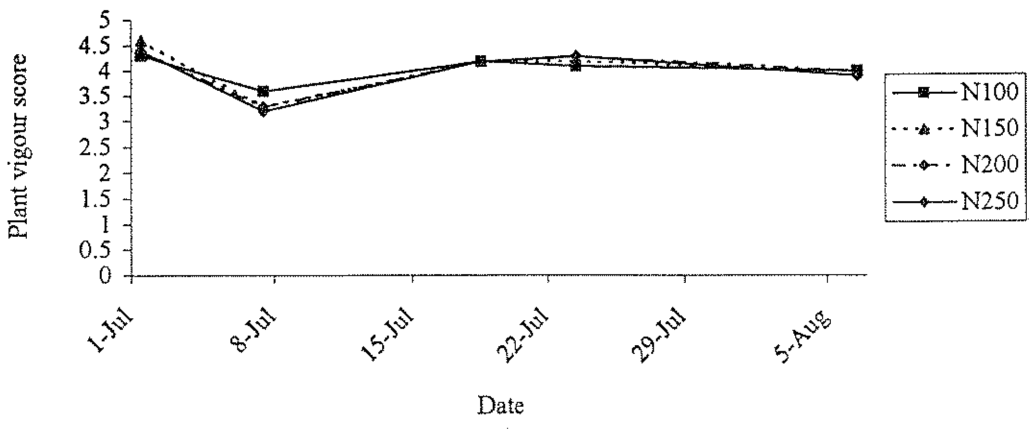


Figure 2b. Effect of nitrogen (ppm) content of the applied feed on overall plant vigour of a summer cucumber crop.



Increasing the nitrogen content of the applied feed also increased the vigour of the first lateral shoot in the winter crop however this effect was not apparent for the second lateral shoot. Lateral vigour in the summer replant crop also exhibited a similar trend but the overall effects of nitrogen concentration were reduced (Table 1).

Table 1 Effect of nitrate content of applied feed on lateral vigour score (0-5, where 5= best).

	Winter		Summer	
Nitrogen concentration	1st lateral shoot	2nd lateral shoot	1st lateral shoot	2nd lateral shoot
100 ppm	2.7	2.8	3.5	3.4
150 ppm	3.5	2.8	3.7	3.9
200 ppm	3.9	3.0	4.2	4.2
250 ppm	4.1	2.8	3.9	4.2

Fruit yield and quality

In the winter crop plants fed at 100 ppm nitrogen produced significantly less cucumbers m^{-2} than those fed at the higher levels (Table 2). These plants also produced a significantly lower weight (kgm^{-2}) of cucumbers (Table 3).

A similar situation was recorded in the summer replant crop (Table 2). Although there was an associated reduction in the total weight of cucumbers produced (kgm^{-2}) for this crop this difference was not statistically significant (Table 3).

Table 2. Effect of nitrogen concentration of the applied feed on the number of marketable (Class I and II) cucumbers m^{-2}.

	Winter				Summer			
[N]	February	March	April	Total	June	July	August	Total
100	6.6	20.0	17.5	47.5	6.6	25.0	6.5	38.1
150	6.8	21.2	22.6	54.9	6.7	27.4	6.5	40.6
200	6.4	20.8	21.9	53.4	6.5	27.9	7.4	41.8
250	7.0	20.9	19.5	51.8	6.5	28.5	7.1	42.0
SED (6 df)	0.41	0.78	1.13	1.04	0.31	0.86	0.36	1.18
LSD (5%)	1.0	1.9	2.8	2.5	0.7	2.0	0.9	2.8
Significance	NS	NS	**	***	NS	*	NS	*

SED at 7 df for summer crop.

Table 3. Effect of nitrogen concentration of the applied feed on the weight (kgm^{-2}) of marketable (Class I and II) cucumbers.

	Winter				Summer			
[N]	February	March	April	Total	June	July	August	Total
100	2.5	8.3	7.2	14.5	3.2	13.1	3.4	19.6
150	2.5	8.4	9.1	22.0	3.2	14.3	3.4	21.0
200	2.4	8.1	8.6	20.7	3.1	14.2	3.9	21.1
250	2.6	8.2	7.6	20.2	3.1	14.5	3.6	21.2
SED (6 df)[1]	0.15	0.31	0.39	0.51	0.08	0.52	0.22	0.59
LSD (5%)	0.4	0.8	1.0	1.2	0.2	1.2	0.5	1.4
Significance	NS	NS	**	**	NS	NS	NS	NS

[1]SED at 7 df for summer crop.

In the winter crop plants fed at 200 ppm nitrogen and 250 ppm nitrogen produced significantly more Class I cucumbers than those grown at 100 ppm nitrogen and 150 ppm nitrogen (Table 4). This corresponds to a significant reduction in the percentage of Class II cucumbers produced (Table 5) and Waste fruit (Table 6). Fruit quality of the summer replant crop was not affected by the nitrogen content of the applied feed (Tables 4 to 6).

Table 4. Effect of nitrogen concentration of the applied feed on Percentage Class I cucumbers.

	Winter				Summer			
[N]	February	March	April	Mean	June	July	August	Mean
100	86.4	96.8	82.9	89.2	99.5	99.0	96.9	98.8
150	93.2	96.0	87.2	91.2	99.3	99.1	96.3	98.7
200	96.9	97.5	90.2	93.6	99.1	99.0	96.4	98.6
250	96.9	97.6	90.4	94.5	98.4	98.2	97.2	98.1
SED (6 df)[1]	1.99	0.71	0.95	0.36	0.87	0.24	1.06	0.25
LSD (5%)	4.9	1.7	2.3	0.9	2.1	0.6	2.5	0.6
Significance	**	NS	***	***	NS	NS	NS	NS

[1]SED at 7 df for summer crop.

Table 5. Effect of nitrogen concentration of the applied feed on Percentage Class II cucumbers.

	Winter				Summer			
[N]	February	March	April	Mean	June	July	August	Mean
100	13.7	3.2	17.1	10.8	0.5	1.0	3.1	1.2
150	6.8	4.0	12.8	8.8	0.7	0.9	3.8	1.3
200	3.1	2.5	9.8	6.1	0.9	1.0	3.6	1.5
250	3.1	2.4	9.6	5.5	1.6	1.9	2.8	2.0
SED (6 df)[1]	1.99	0.71	0.95	0.36	0.87	0.24	1.06	0.25
LSD (5%)	4.9	1.7	2.3	5.6	2.1	0.6	2.5	0.6
Significance	**	NS	***	***	NS	**	NS	NS

[1]SED at 7 df for summer crop.

Table 6. Effect of nitrogen concentration of the applied feed on % waste fruit.

	Winter				Summer			
[N]	February	March	April	Mean	June	July	August	Mean
100	0	2.6	7.7	4.4	0.7	0.6	2.1	0.9
150	0.3	2.1	5.6	3.4	0.6	0.5	3.0	0.9
200	0.6	1.6	6.1	3.4	0.9	0.2	2.5	0.7
250	0.2	1.3	6.2	3.1	1.1	0.4	2.8	0.9
SED (6 df)[1]	0.43	0.56	1.17	0.71	0.43	0.21	1.49	0.37
LSD (5%)	1.1	1.4	2.9	1.7	1.0	0.5	3.5	0.9
Significance	NS	NS	NS	NS	NS	NS	NS	NS

[1]SED at 7 df for summer crop.

The mean weight (g) of individual cucumbers was significantly increased at the lower rates of applied nitrogen for the winter crop (Table 7). This was probably due to the lower numbers of cucumbers produced m^{-2} for these treatments (Table 2). As expected the summer replant crop produced heavier cucumbers. Although a similar trend was observed for this crop, with low nitrogen applications producing heavier cucumbers, these differences were not statistically different (Table 7).

Table 7. Effect of nitrogen concentration of the applied feed on mean weight (g) per marketable cucumber.

	Winter				Summer			
[N]	February	March	April	Mean	June	July	August	Mean
100	373	417	409	411	487	522	524	516
150	373	398	402	401	482	523	532	517
200	371	387	393	387	467	509	524	505
250	371	395	390	390	474	511	510	505
SED (6 df)[1]	2.58	1.65	5.18	2.83	15.6	9.8	14.7	8.8
LSD (5%)	6.3	4.0	12.7	6.9	36.9	23.2	34.8	20.8
Significance	NS	***	*	***	NS	NS	NS	NS

[1]SED at 7 df for summer crop.

The nitrogen content of the applied hydroponic feed had highly significant (P>0.001%) effects on the size distribution of cucumbers for the winter crop with the plants fed at the lower rates of applied nitrate producing heavier cucumbers (Table 8). The nitrogen content of the applied feed had no significant effect on the size distribution of the fruit in the summer replant crop although similar trends were observed (Table 8).

Table 8. Effect of nitrogen concentration of the applied feed on Percentage size grades of marketable yield.

	Winter				Summer			
[N]	February	March	April	Mean	June	July	August	Mean
Size 250 – 400g								
100	82.6	55.9	58.9	59.3	32.4	21.6	22.0	23.6
150	81.0	66.3	62.6	65.3	32.2	21.4	21.3	23.3
200	85.6	72.3	66.7	70.9	38.0	24.1	24.9	26.4
250	81.5	70.1	68.6	70.7	34.5	24.3	25.3	26.0
SED (6 df)[1]	2.06	1.83	2.90	0.98	4.47	2.82	4.26	2.73
LSD (5%)	5.0	4.5	7.1	2.4	10.6	6.7	10.1	6.5
Significance	NS	***	*	***	NS	NS	NS	NS
Size 400 – 500g								
100	15.5	30.6	27.2	27.0	26.9	27.7	25.8	27.5
150	17.6	29.9	25.6	25.7	29.8	27.5	27.5	28.0
200	13.7	23.5	22.0	22.0	28.7	28.6	23.8	27.6
250	17.1	24.7	22.7	22.8	29.9	28.2	28.6	28.8
SED (6 df)[1]	2.12	1.65	1.28	0.59	2.07	.58	2.32	0.70
LSD (5%)	5.1	4.0	3.1	1.4	4.9	1.4	5.5	1.7
Significance	NS	**	**	***	NS	NS	NS	NS
Size 500 – 650g								
100	1.9	11.0	10.2	10.5	27.0	28.5	26.4	27.8
150	1.4	6.2	9.5	7.5	25.8	30.5	27.5	29.0
200	0.7	3.9	8.6	5.9	24.2	29.5	27.3	28.5
250	1.4	5.0	7.0	5.5	24.4	28.4	27.3	27.4
SED (6 df)[1]	0.71	0.81	1.51	0.51	2.39	1.50	2.80	1.55
LSD (5%)	1.7	2.0	3.7	1.2	5.7	3.5	6.6	3.7
Significance	NS	***	NS	***	NS	NS	NS	NS
Size 650 – 800g								
100	0	2.6	3.7	3.2	13.7	22.2	25.7	21.2
150	0.1	0.5	2.3	1.6	12.2	20.7	23.6	19.6
200	0	0.3	2.7	1.2	9.1	17.9	24.0	17.5
250	0	0.2	1.7	1.0	11.2	19.1	18.8	17.9
SED (6 df)[1]	0.08	0.41	0.59	0.15	2.27	2.01	3.02	1.65
LSD (5%)	0.2	1.0	1.4	0.37	5.4	4.8	7.1	3.9
Significance	NS	**	NS	***	NS	NS	NS	NS

[1]SED at 7 df for summer crop.

2. Effect of transplant age on plant establishment

Growth rate

Older transplants in both the winter and summer crops had greater root development (root score) and number of leaves recorded at the time of transplanting (Table 9).

Table 9 Roots score (0 – 5 where 5=best*) and number of leaves, recorded at planting for the two transplant ages in the winter and summer replant crops

	Winter		Summer	
	Root score*	No. of leaves	Root score*	No. of leaves
Old 30 (21) days	3.5	5.4	3.6	7.6
Young 26 (18) days	3.0	3.8	1.1	5.7

(Transplant age of summer crop)

The older transplants in the winter (30 days) and summer (21 days) crops exhibited an increased rate of growth compared to the younger, 26 day and 18 day old transplants respectively (Figure 3). For the winter crop the differences in growth rate were still apparent 14-21 days after transplanting. Plant growth rates were increased in the summer crop and the young (18 day) transplants effectively caught up between 7-14 days after transplanting. (Figure 3).

Plant vigour assessments

The overall plant vigour was greater in the older (30 day) winter transplants than the young (26 day) transplants during the establishment phase (3 weeks) after transplanting after which time there was no recorded difference (Figure 4).

Transplant age produced no visible effect on overall plant vigour in the summer crop.
A fall in plant vigour recorded 7 days after transplanting, for both ages can be attributed to the high temperatures in the house and insufficient rooting into the rockwool slabs (Figure 4).
Older transplants also increased the vigour of the first lateral shoot in the winter crop (Table 10). However no difference was recorded in lateral vigour between old and young transplants for the summer replant crop (Table 10).

Figure 3 Effect of transplant age on daily growth rate of a winter and summer replant cucumber crop.

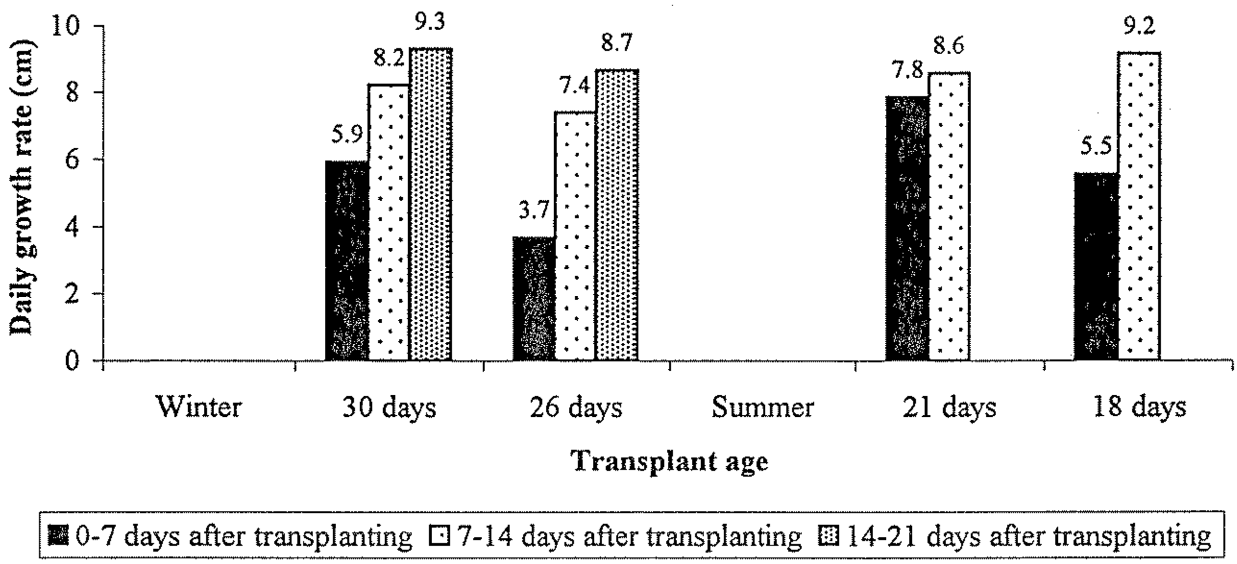


Figure 4 Effect of transplant age on overall plant vigour of a winter and summer replant cucumber crop.

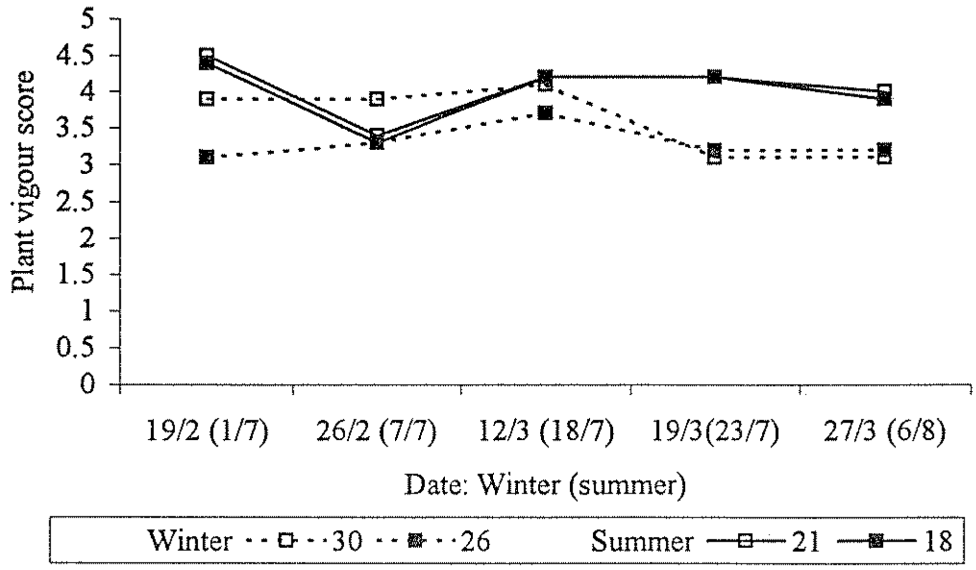


Table 10. Effect of transplant age on lateral vigour score (0-5, where 5 = best).

	Winter		Summer	
	1st lateral shoot	2nd lateral shoot	1st lateral shoot	2nd lateral shoot
30 (21) days	3.8	2.8	3.8	3.9
26 (18) days	3.3	2.9	3.9	3.9

(Transplant age of summer crop)

Yield and fruit quality

The number of marketable cucumber m^{-2} was significantly increased for the older transplants in the winter (30 day) and summer replant (21 day) crops. The differences in each case were due to yield increases during the early stages of picking (Table 11).

There was also a significant effect of transplant age on the weight (kgm^{-2}) of cucumbers produced with the older transplants in each crop producing a greater weight of cucumbers during the early stages of picking (Table 12).

Table 11. Effect of transplant age on number of marketable cucumbers (Class I and II) m^{-2}.

	Winter				Summer			
Plant age	February	March	April	Total	June	July	August	Total
30 (21) days	7.8	20.8	20.3	53.1	8.3	26.1	6.9	41.3
26 (18) days	5.6	20.7	20.5	50.7	4.9	28.3	6.8	40.0
SED (24df)	0.19	0.28	0.71	0.77	0.31	0.86	0.31	0.46
LSD (5%)	0.4	0.6	1.5	1.6	0.6	1.8	0.6	0.95
Significance	***	NS	NS	**	***	**	NS	***

(Transplant age of summer crop)

Table 12. Effect of transplant age on weight (kgm^{-2}) of cucumbers.

	Winter				Summer			
Plant age	February	March	April	Total	June	July	August	Total
30 (21) days	2.9	8.3	8.1	21.2	4.0	13.7	3.7	21.3
26 (18) days	2.1	8.2	8.1	20.0	2.3	14.4	3.5	20.2
SED (24df)	0.07	0.13	0.28	0.34	0.12	0.23	0.18	0.29
LSD (5%)	0.1	0.3	0.6	0.7	0.2	0.5	0.4	0.6
Significance	***	NS	NS	**	***	**	NS	***

(Transplant age of summer crop)

There was a small but significant reduction in the percentage of Class I fruit produced by the old transplants in the winter crop. This affected only the first few fruit and was accompanied by small but significant increases in Class II and Waste fruit (Tables 13 to 15). There was no effect of transplant age on fruit quality for the summer replant crop (Tables 13 to 15).

Table 13. Effect of transplant age on percentage Class I cucumbers.

	Winter				Summer			
Plant age	February	March	April	Mean	June	July	August	Mean
30 (21) days	92.8	96.5	87.2	91.6	99.3	98.9	96.3	98.6
26 (18) days	93.8	97.5	88.1	92.8	98.8	98.7	97.1	98.5
SED (24df)	1.14	0.52	0.93	0.50	0.44	0.22	0.85	0.22
LSD (5%)	2.4	1.1	1.9	1.0	0.9	0.5	1.8	0.5
Significance	NS	NS	NS	*	NS	NS	NS	NS

(Transplant age of summer crop)

Table 14. Effect of transplant age on percentage Class II cucumbers.

	Winter				Summer replant			
Plant age	February	March	April	Mean	June	July	August	Mean
30 (21) days	7.2	3.5	12.8	8.3	0.7	1.1	3.7	1.5
26 (18) days	6.2	2.5	11.9	7.2	1.2	1.3	2.9	1.5
SED (24df)	1.14	0.52	0.93	0.50	0.44	0.22	0.85	0.22
LSD (5%)	2.4	1.1	1.9	1.0	0.9	0.5	1.8	0.5
Significance	NS	NS	NS	*	NS	NS	NS	NS

(Transplant age of summer crop)

Table 15. Effect of transplant age on Waste cucumbers.

	Winter				Summer replant			
Plant age	February	March	April	Mean	June	July	August	Mean
30 (21) days	0.3	2.2	7.1	3.8	1.1	0.4	1.7	0.9
26 (18) days	0.3	1.6	5.7	3.3	0.6	0.4	1.2	0.8
SED (24df)	0.21	0.29	0.48	0.20	0.4	0.16	0.27	0.21
LSD (5%)	0.4	0.6	1.0	0.4	0.8	0.3	0.6	0.4
Significance	NS	NS	**	*	NS	NS	NS	NS

(Transplant age of summer crop)

Transplant age had no effect on the mean weight of individual cucumbers in the winter crop (Table 16). However older (21day) transplants in the summer replant crop produced significantly (P=0.001%) heavier cucumbers compared to the younger (18 day) transplants (Table 16). The fruit size distribution was not influenced by transplant age in the winter crop. However the older transplants in the summer replant crop produced significantly more fruit in the 650 – 800g grade compared to the younger transplants (Table 17).

Table 16. Effect of transplant age on mean weight (g) per cucumber.

	Winter				Summer			
Plant age	February	March	April	Mean	June	July	August	Mean
30 (21) days	375	400	400	399	484	523	533	516
26 (18) days	369	399	397	395	471	509	513	505
SED (24df)	2.73	2.85	2.77	2.53	5.24	3.32	5.06	2.62
LSD (5%)	5.6	5.9	5.7	5.2	10.8	6.9	10.4	5.4
Significance	NS	NS	NS	NS	*	***	***	***

(Transplant age of summer crop)

Table 17. Effect of transplant age on percentage size grade of marketable yield.

	Winter				Summer			
Plant age	February	March	April	Mean	June	July	August	Mean
Size 250 – 400g								
30 (21) days	80.5	65.2	63.4	65.9	35.6	21.5	21.5	24.3
26 (18) days	84.8	67.0	65.0	67.3	33.0	24.2	25.3	25.4
SED (24df)	1.44	1.34	1.45	0.82	2.28	1.03	1.80	0.89
LSD (5%)	3.0	2.77	2.99	1.69	4.7	2.1	3.7	1.8
Significance	**	NS	NS	NS	NS	*	*	NS
Size 400 – 500g								
30 (21) days	17.9	27.5	24.6	24.8	29.4	27.4	25.7	27.6
26 (18) days	14.1	25.3	24.2	23.9	28.3	28.6	27.1	28.4
SED (24df)	1.25	1.10	1.00	0.70	1.50	0.78	1.48	0.67
LSD (5%)	2.6	2.3	1.1	1.4	3.1	1.6	3.1	1.4
Significance	**	NS	NS	NS	NS	NS	NS	NS
Size 500 – 650g								
30 (21) days	1.5	6.2	9.3	7.4	21.6	29.1	27.9	27.5
26 (18) days	1.2	6.8	8.4	7.2	29.1	29.4	26.4	28.9
SED (24df)	0.40	0.52	0.91	0.39	2.07	0.90	1.76	0.68
LSD (5%)	0.8	1.1	1.9	0.8	4.3	1.9	3.6	1.4
Significance	NS	NS	NS	NS	**	NS	NS	NS
Size 650 – 800g								
30 (21) days	0.1	1.0	2.8	1.9	13.4	22.0	24.9	20.7
26 (18) days	0	0.8	2.5	1.6	9.7	17.9	21.2	17.4
SED (24df)	0.05	0.32	0.41	0.24	1.13	0.93	1.63	0.71
LSD (5%)	0.1	0.7	0.8	0.5	2.3	1.9	3.4	1.5
Significance	NS	NS	NS	NS	*	***	*	***

(Transplant age of summer crop)

EXPERIMENT 3: Effect of shading and irrigation regime on plant establishment

Materials and Methods

Cultural details

Sown:	22 July
Planted:	12 August
Date of first pick:	29 August
Final harvest:	30 October

Treatments

Varieties: Jessica
Enigma

Irrigation:

High afternoon (every 50 J or 1.25 hours) from noon to 1 hour before sunset. Morning 66% of Standard (T3).

High morning (every 50 J or 1.25 hours) from 1 hour before sunrise to 12 noon. Afternoon 66% of standard (T3).

Standard (every 100 J or 2.5 hours) from 1 hour before sunrise to 1 hour before sunset.

High all day.

* The volume of irrigation applied per start increased as the plants grew and was calculated to give 30% run-off on the standard treatment. In practice volumes began at approximately 60 ml per plant per start and rose to approximately 200 ml per plant per start.

Irrigation treatments ran until the 26 August (12 days) after which all plants were irrigated using the standard regime.

Shading: No shade
Shade

A non-woven fleece was placed over the crop wires to provide approximately 10% shading on the crop. The fleece was removed once the plants had reached the wire on 2 September.

Experimental design

The plots consisted of 5 rockwool slabs with 10 plants to a plot. Plant spacing was 0.45m x 1.6m. Treatments consisted of all combinations of two varieties, 4 irrigation regimes and 2 levels of shading.

Records and assessments

Yield (kgm^{-2}) and quality (Class I and II).
Total fresh weight of crop at the end of the trial
Weekly plant height (cm).
Weekly plant vigour score (0-5, where 5 = best).
Weekly nutrient analysis.

Results

Plant growth and vigour

There were no recorded differences in plant growth rate overall plant vigour or lateral shoot vigour for the shading and irrigation treatments (data not shown).

Effect of shading and irrigation regime on root temperature

In this trial there was no effect of shading or irrigation regime on slab temperature (Figure 5). It should be possible to influence slab temperatures by applying high volumes of cold water at different times of the day. However during the course of this experiment the outside air temperatures were not as high as those sometimes experienced during the establishment phase of a summer crop, and this may have influenced the results.

Fruit yield and quality

There were no effects of irrigation regime on the number of cucumbers produced m^{-2} (Table 18) or weight of cucumber produced (kgm^{-2}) (Table 19). There were also no significant differences in fruit quality (Tables 20 and 21). The irrigation regime also had no significant effect on the mean weight of individual cucumbers (Table 22) or on the fruit size distribution (Table 23).

Figure 5 Effect of irrigation treatments on the average slab temperatures measured from 16 - 21 August.

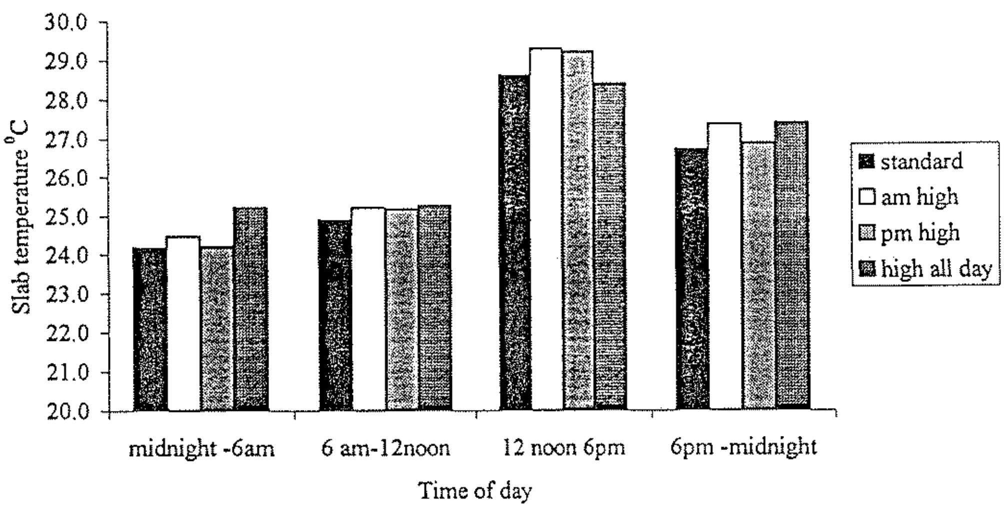


Table 18. Effect of irrigation regime on number of marketable (Class I and II) cucumber m^{-2}

Irrigation regime	September	October	Total
High pm	23.6	14.5	38.1
High am	23.9	14.0	37.9
Standard	23.7	15.0	38.7
High all day	24.3	14.4	38.6
SED (7 df)	0.66	0.63	1.07
LSD (5%)	1.6	1.5	0.2
Significance	NS	NS	NS

Table 19. Effect of irrigation regime on weight (kgm^{-2}) marketable cucumbers.

Irrigation regime	September	October	Total
High pm	9.7	5.9	15.6
High am	9.6	5.5	15.1
Standard	9.6	6.0	15.6
High all day	9.9	5.7	15.6
SED (7 df)	0.24	0.20	0.36
LSD (5%)	0.6	0.5	0.9
Significance	NS	NS	NS

Table 20. Effect of irrigation regime percentage Class I cucumbers.

Irrigation regime	September	October	Mean
High pm	93.3	93.5	93.4
High am	91.0	93.7	92.1
Standard	91.3	94.5	92.6
High all day	93.1	95.3	94.0
SED (7 df)	1.25	1.15	1.14
LSD (5%)	3.0	2.7	2.7
Significance	NS	NS	NS

Table 21. Effect of irrigation regime on percentage Class II cucumbers.

Irrigation regime	September	October	Mean
High pm	6.7	6.5	6.6
High am	9.0	6.3	7.9
Standard	8.7	5.5	7.4
High all day	6.9	4.7	6.0
SED (7 df)	1.25	1.15	1.14
LSD (5%)	3.0	2.7	2.7
Significance	NS	NS	NS

Table 22. Effect of irrigation regime on mean weight (g) marketable cucumber.

Irrigation regime	September	October	Total
High pm	412	407	410
High am	400	393	398
Standard	404	403	403
High all day	407	396	403
SED (7 df)	8.26	5.93	6.35
LSD (5%)	19.5	7.5	15.0
Significance	NS	NS	NS

Table 23. Effect of irrigation regime on percentage size grades marketable cucumber.

Irrigation regime	September	October	Mean
Size 250 – 400g			
High pm	57.3	60.0	58.4
High am	62.5	64.0	63.0
Standard	62.2	62.9	62.6
High all day	60.2	63.9	61.6
SED (7 df)	3.00	2.03	2.46
LSD (5%)	7.1	4.8	5.8
Significance	NS	NS	NS
Size 400 – 500g			
High pm	29.8	26.3	28.4
High am	28.3	25.6	27.3
Standard	26.2	25.4	25.9
High all day	29.4	25.1	27.8
SED (7 df)	2.17	1.11	1.64
LSD (5%)	5.1	2.6	3.9
Significance	NS	NS	NS
Size 500- 650g			
High pm	11.2	11.3	11.2
High am	8.2	9.5	8.7
Standard	10.2	10.1	10.1
High all day	9.0	9.0	9.0
SED (7 df)	1.14	1.59	1.19
LSD (5%)	2.7	3.8	2.8
Significance	NS	NS	NS
Size 650 – 800g			
High pm	1.8	2.4	2.0
High am	1.0	0.9	1.0
Standard	1.3	1.6	1.4
High all day	1.4	2.1	1.7
SED (7 df)	0.59	0.97	0.38
LSD (5%)	1.4	2.3	0.9
Significance	NS	NS	NS

Discussion

It has been demonstrated (HDC PC111) that the nitrogen levels in the feed applied to cucumbers can be reduced to 150 ppm once the crop has reached maturity. During establishment and the early stages of harvesting the plants have a much higher demand for nitrogen. It is essential to establish plants quickly and to commence harvesting as soon as possible in order to maximise yields. Factors that can influence plant establishment and early yields are nitrogen concentration, transplant age and root temperatures, especially in the summer replant crop.

Reducing the nitrogen concentration of the applied feed restricted plant growth rates and the vigour of the 1st lateral shoot. As the nitrogen concentration was increased the growth rate and overall vigour of the plant and 1st lateral shoot increased (Table 1). These effects were more pronounced in the winter crop than the summer replant crop and maybe attributed to the low light levels experienced during the early stages of a winter crop.

Low (100ppm) concentrations of applied nitrogen significantly reduced the number and weight of cucumbers produced m^{-2} in both the winter and summer replant crop. Feeding at the highest level (250 ppm) also reduced the number of cucumbers produced m^{-2} in the winter crop compared feeding at 150 and 200 ppm a result obtained in earlier trials (PC 110). In the summer replant plants fed at 250 ppm produced the greatest number of cucumbers m^{-2}. The differences observed between the winter and summer replant crop is probably due to an interaction with the light levels. Plants fed at 250 ppm in the summer were able to utilise more of the applied nitrogen at the higher light levels.

The nitrogen concentration of the applied feed had no effect on the percentage of Class I fruit produced in the summer replant crop. However feeding at 100 ppm nitrogen in the winter crop significantly reduced the percentage of Class I fruit during the later stages of harvesting (Table 4).

Older transplants established better by exhibiting increased growth rates especially in the winter crop. Transplant age had a similar but reduced effect in the summer replant crop. The older plants had better root development, measured as root score, and had produced more leaves at the time of transplanting (Table 9). The increased leaf area seems to particularly important for increasing the growth rates of the old transplants in the winter crop probably because of the low light levels at this time of year.

The older transplants in both the winter and summer replant crops produced significantly higher yields during the initial harvesting periods. During the later stages of the harvesting these differences disappeared (Tables 11 and 12). However the initial yield increases were sufficient to significantly increase total yields recorded at the end of the trial.

Fruit quality was largely unaffected by transplant age, although the yield of Class I fruit was reduced in the winter crop by 1.2% from using older transplants. The reasons for this are unclear.

The establishment of a summer replant crop can be impeded by high ambient and root temperatures. In the final experiment shading combined with increased irrigation volumes were used to try and influence plant establishment by lowering slab temperatures to aid rooting.

Slab temperatures were not reduced by either treatment and there were no effects on yield or quality of the cucumbers produced. In theory it should be possible to reduce slab temperatures by applying cold water and therefore aid plant establishment when temperatures are high. However the weather conditions during the establishment period of this trial were not as high as that sometimes observed and the treatments had no effect.

Conclusions

Nitrogen concentration of the applied feed

- During the establishment phase cucumbers have a high demand for nitrogen. Mature plants that are producing fruit have a reduced demand for nitrogen.
- The vigour of the first lateral shoot was reduced at low levels of applied nitrogen.
- Applied nitrogen levels of 100 and 250ppm reduced the number and weight of cucumber produced m^{-2} in the winter crop. Nitrogen concentration had no significant effect on crop productivity in the summer replant crop.
- Applied nitrogen concentrations of 100 and 150 ppm reduced the percentage Class I fruit in the winter crop. Nitrogen concentration had no significant effect on fruit quality in the summer replant crop.
- A reduction in the concentration of applied nitrogen led to a significant increase in mean fruit weight (g) for the winter crop.

Transplant age

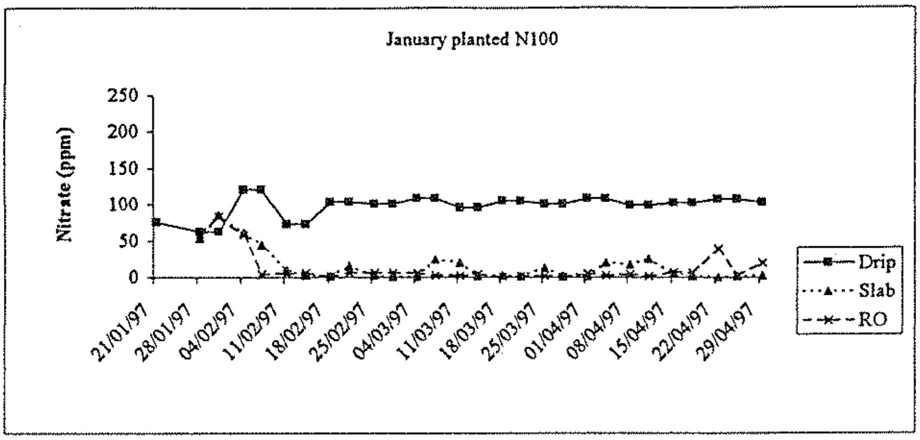
- Growth rate of older transplants was greater than young transplants in both the winter and summer replant crops. The effects were greatest in the winter crop.
- Older transplants were more productive during the early stages of harvesting.
- Older transplants produced slightly less Class I fruit in the winter crop. There was no effect of transplant age on fruit quality for the summer replant crop.

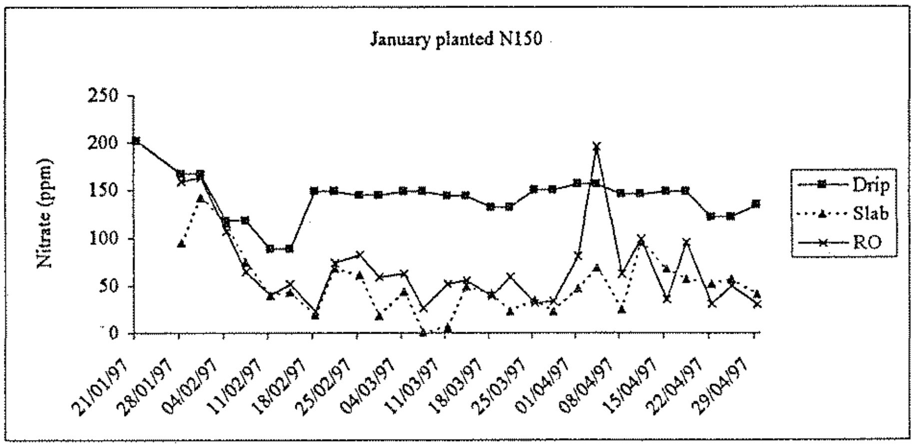
Irrigation regime

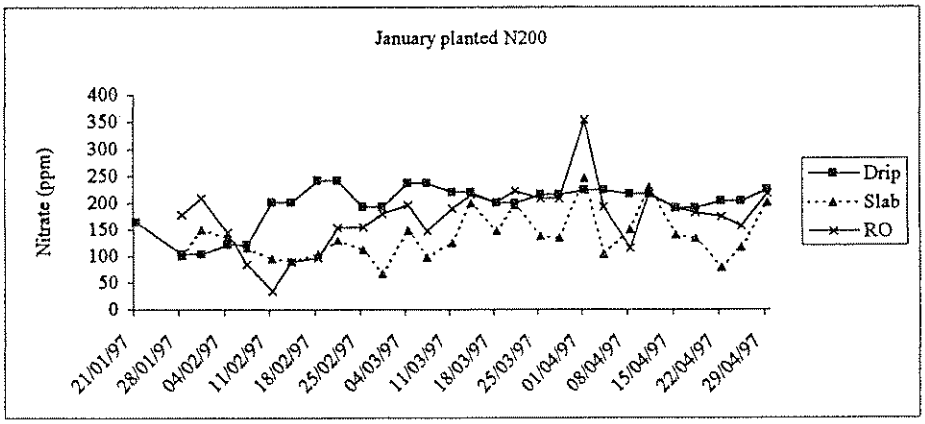
- Slab temperature was not effected by irrigation regimes.

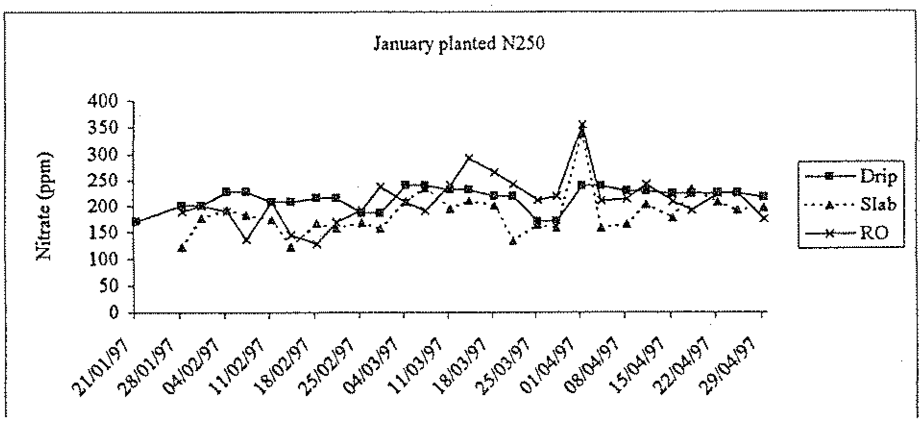
- Irrigation regime had no effect on the growth or productivity of the cucumber crop.

Appendix 1a
Nitrogen levels of the drip, slab and run-off solutions for the winter crop









Appendix 1b
Nitrogen levels of the drip, slab and run off solutions for the summer crop.