FINAL REPORT

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A REPORT TO THE HORTICULTURAL DEVELOPMENT COUNCIL
18 LAVANT STREET, PETERSFIELD, HANTS, GU32 3EW

REVIEW OF 'PIGTAIL' IN CUCUMBERS

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 .....

Mrs M Hardgrave
Project Leader

Date ..27/4/94....

Report authorised by .....
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Relevance to Growers and Practical Application

The term 'pigtail' is used to describe serious fruit deformation in cucumbers, whereby the small fruit twists into a tight curl and develops into an unmarketable cucumber.

It has generally been presumed that the curling is caused by thrips, particularly *Frankliniella occidentalis* (western flower thrips), but some recent evidence suggests that pigtail damage can also be very severe in crops with low thrips populations and vice versa.

This review aimed to identify the connection between cultural, environmental and nutritional factors, and fruit curling as well as considering the effect of pests, particularly thrips.

Results

The survey provided a useful guide to the extent of the problems within the UK and the losses incurred by the industry, in particular the high economic losses that can be caused by damage to the replanted crop.

The results of this survey do not provide a positive answer to the cause of pigtail in cucumber crops but eliminates some factors and suggests areas for further investigation.

1. Pigtail has become a more significant problem since 1988.

2. The level of pigtail damage increases to a peak in July and August, and it is most common on replanted crops.

3. Pigtail did not occur in crops where thrips were not present. However, very low thrips populations can be present without resulting in pigtail and conversely high thrips populations can cause severe damage. Therefore, there is no direct relationship between thrips population and level of pigtail damage.

4. Some varieties are more susceptible to damage.

5. Agronomic factors such as substrate, temperature, nutrient levels and growing system are not associated with pigtail damage, and can be elimianted from further studies.

Areas for Further Investigation

The cause of damage appears to be an interaction of cultivar, plant condition, which in turn is related to environment, and presence of thrips.

The frequency and severity of the problem show that this is an area which requires further study.

Introduction

The term 'pigtail' is used to describe serious fruit deformation in cucumbers, whereby the small fruit twists into a tight curl and develops into an unmarketable cucumber.

It has generally been presumed that the curling is caused by thrips, particularly *Frankliniella occidentalis* (western flower thrips), but some recent evidence suggests that pigtail damage can also be very severe in crops with low thrips populations and vice versa.

This review aims to identify the connection between cultural, environmental and nutritional factors, and fruit curling as well as considering the effect of pests, particularly thrips.

Materials and Methods

Questionnaire

A questionnaire (see Appendix I) was sent to all cucumber growers registered with the HDC. 160 questionnaires were sent out.

The questionnaire was devised following discussions between agronomists, entomologists, plant pathologyists and leading industry representatives.

30 completed questionnaires were returned, representing 21% of the UK cucumber growing area.

Other Information

A literature search was carried out and Dutch researchers at Naaldwijk were contacted in order to collect all available information on pigtail fruit distortion.

Results

Levels of Damage

Of the growers that responded 53% had suffered pigtail damage to some extent in their first crop. 7% had over 20% of fruit affected.

60% of growers replanted in mid-season and of these 72% suffered pigtail damage. 28% had over 20% of fruit affected.

In general fruit on the mainstem of the first crop was not affected, except where regrowth occurred.

Thereafter, levels of damage on the laterals and on mainstem plus laterals of the second crop were all similar at 10-15% although it was common for individual growers to experience the problem on only the mainstem or only the laterals.

Estimated marketable yield loss is shown in Table 1.

Table 1:

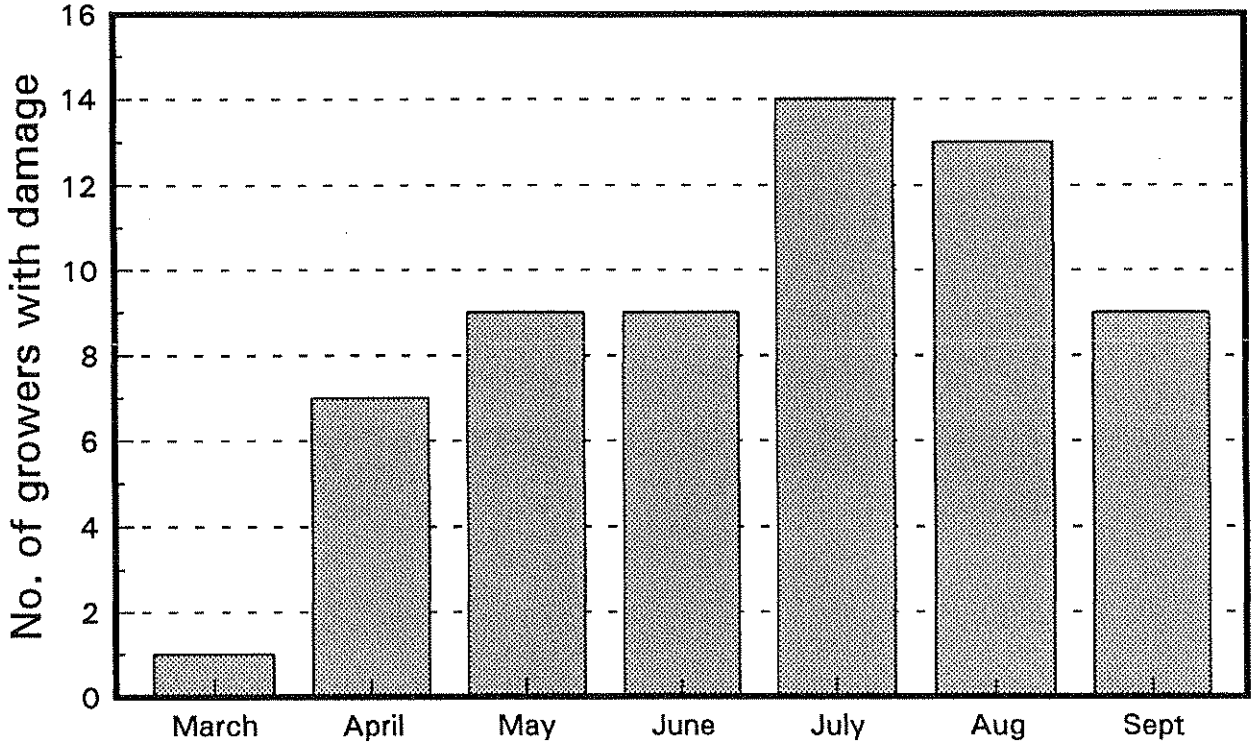
Estimated marketable yield loss due to pigtail in 1992 (%)		
	First Crop	Replanted Crop
Mainstem	5.0	10.1
Laterals	8.3	8.6

Losses were highest from the mainstem of the replanted crop.

One grower saw pigtail as far back as 1976 but otherwise the problem seems to have become common from 1988 onwards.

Damage was not seen before March but then gradually increased throughout the season, reaching a peak in July and August and decreasing again in September (Figure 1).

Fig.1 Periods when pigtail was observed



Distribution of the problem varied considerably but most commonly damage was even throughout the nursery (Table 2).

Table 2:

Distribution of pigtail damage*	
Even throughout nursery	41%
Even distribution within some blocks	18%
Scattered plants here and there	18%
Groups of plants	23%

* Percentage of growers who suffered from pigtail damage.

Agronomic Factors

None of the growers who responded recorded differences in the level of damage between different ages of glasshouses and only two growers could identify any difference between growing environments. They referred specifically to high EC and low root temperatures where pigtail occurred.

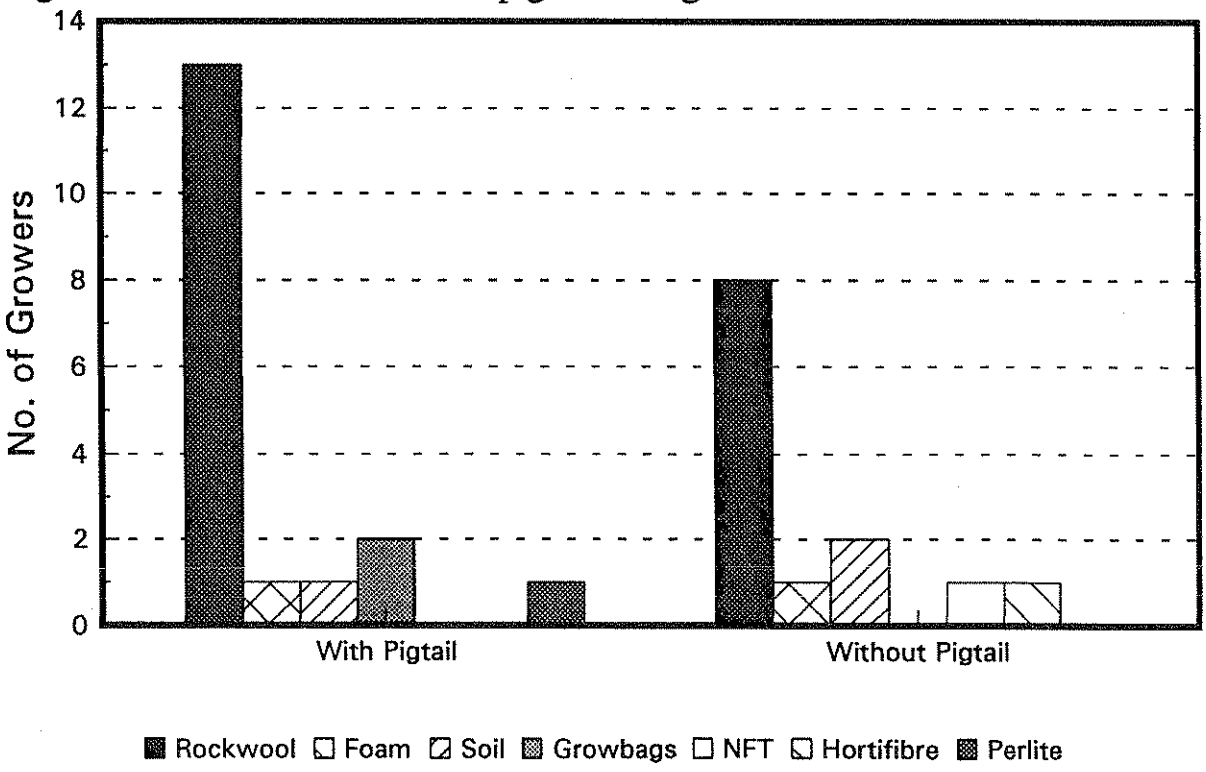
20% of growers who suffered from pigtail damage related different levels of damage to different planting dates, commenting on the increased damage when replanting.

Substrate

Rockwool was the most common substrate, although foam, perlite, hortifibre, soil and NFT were also used.

There was no indication that levels of pigtail damage were related to the growing medium.

Fig.2 The effect of substrate on pigtail damage

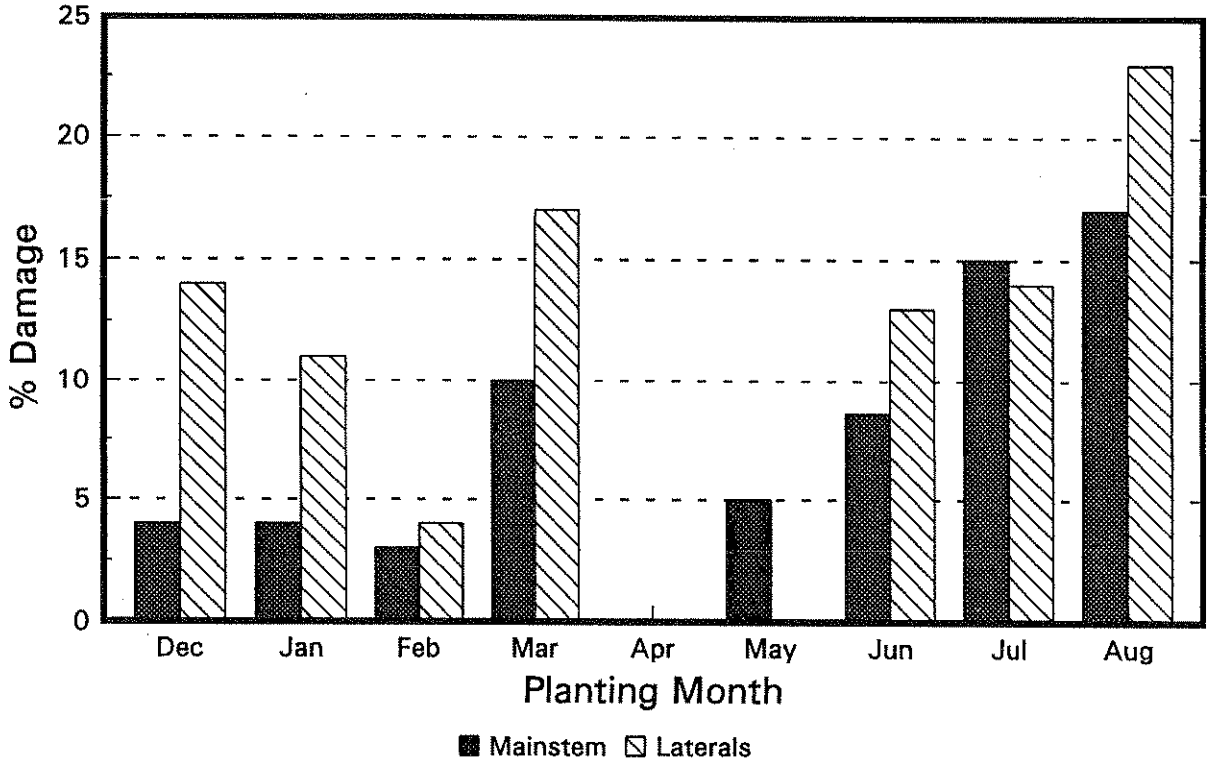


Planting Date

From early plantings the level of damage on the mainstem was low, but higher on the laterals (Figure 3).

From later plantings, particularly July and August, both mainstem and lateral damage were severe.

Fig.3 The effect of planting date



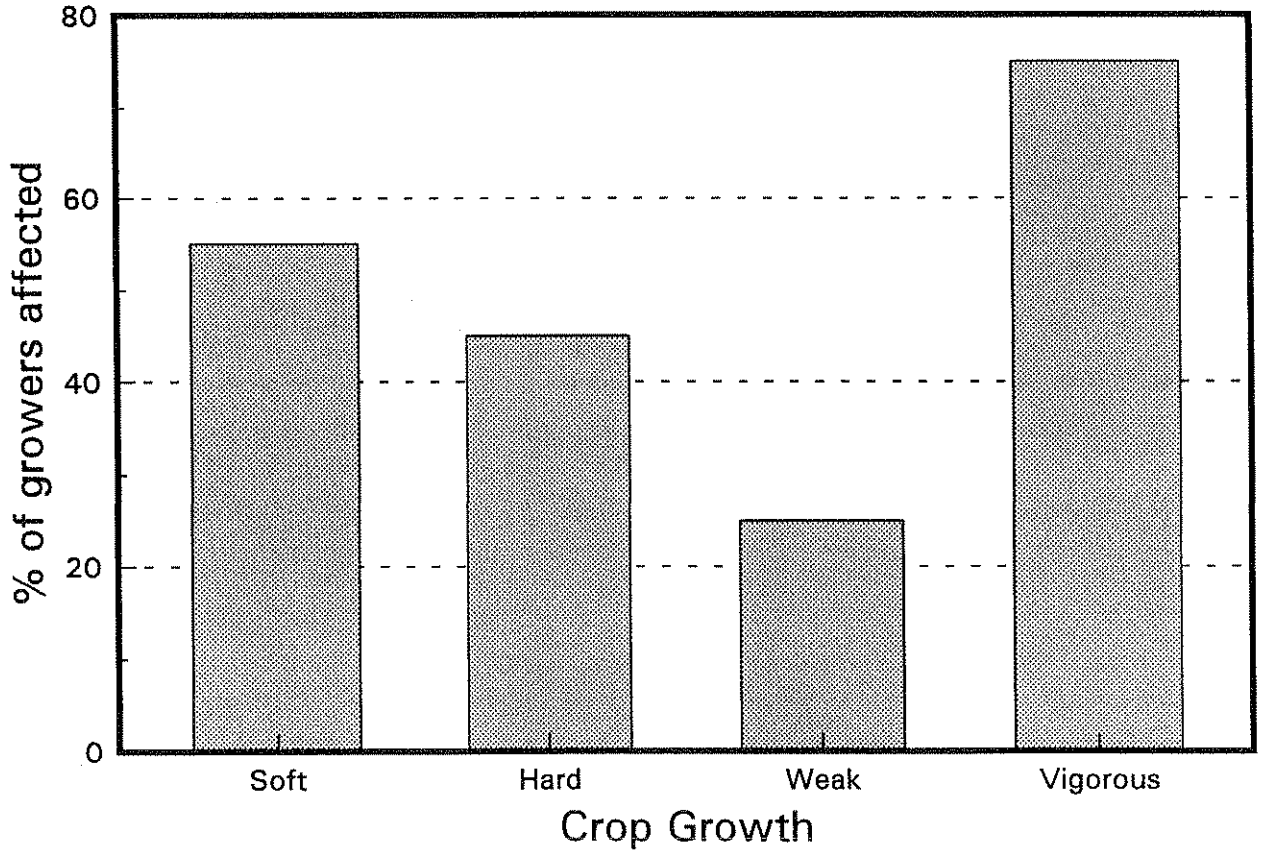
Plant Growth

Of the growers who suffered from pigtail damage 12% reported that a scar was always present on the inside of the curled fruit. The other 88% stated that a scar was sometimes present.

There is sometimes minor fruit damage caused during normal trimming operations within a cucumber crop. The majority of growers who experienced pigtail however reported nil or very light damage to both mainstem and lateral fruit and did not associate this with fruit curling.

Figure 4 shows the type of crop growth that was present when damage was most common.

Fig.4 Plant growth when pigtail occurred.



The results show that where pigtail occurred growth was more likely to be vigorous than weak. This type of vigorous growth tends to be soft rather than hard.

Temperature

None of the growers that suffered from pigtail were able to identify any difference from normal in glasshouse temperature at the time the problem occurred.

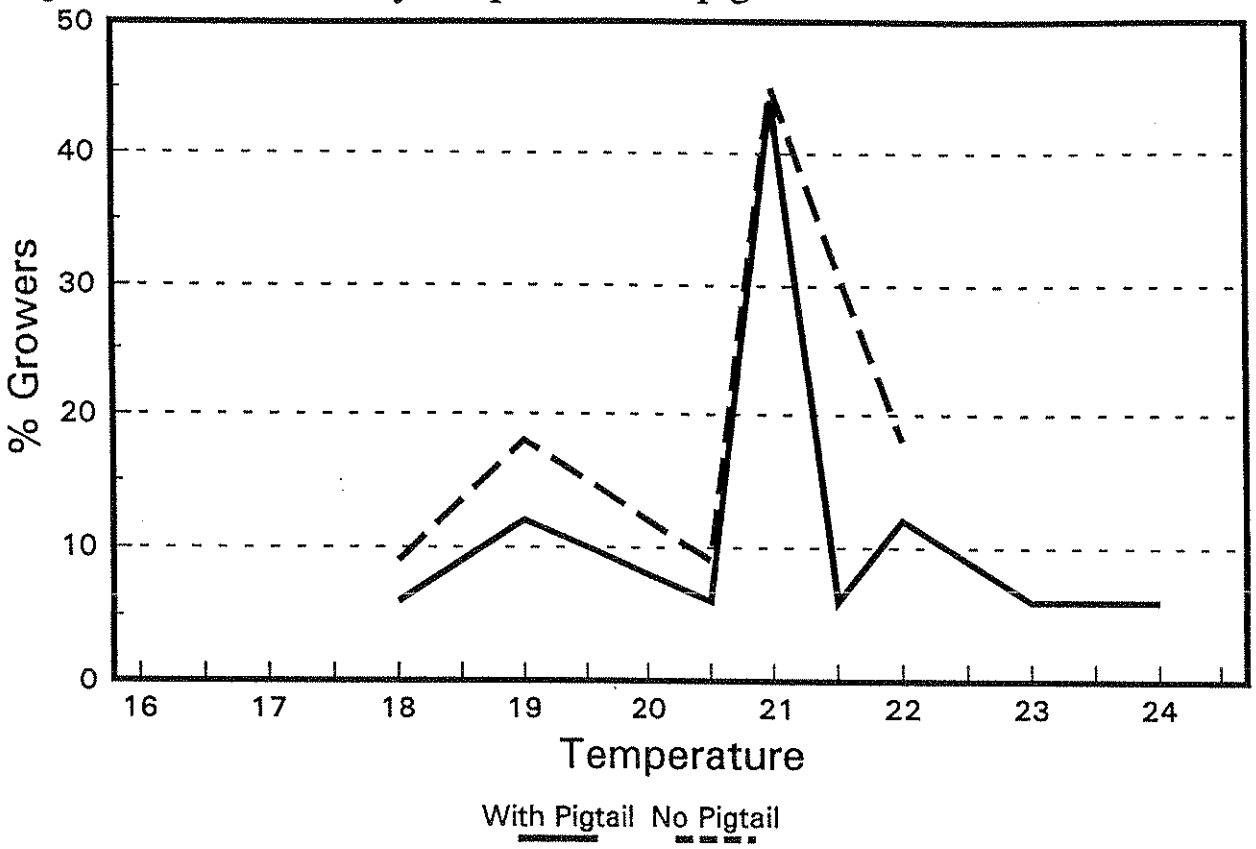
Temperature setpoints ranged from 18-24°C in the day and 16-22°C night where there was a problem and 18-21° day, 16-21°C were there was not (Figure 5).

Nutrient Solution

One grower who grew one crop at particularly high EC (3500) reported that symptoms were worse under those conditions but otherwise within the standard EC ranges there was no indication that incidence of pigtail was related to solution concentration (Figure 6a).

There was no indication that solution pH affected levels of pigtail damage.

Fig.5 The effect of day temperature on pigtail



Effect of night temperature on pigtail

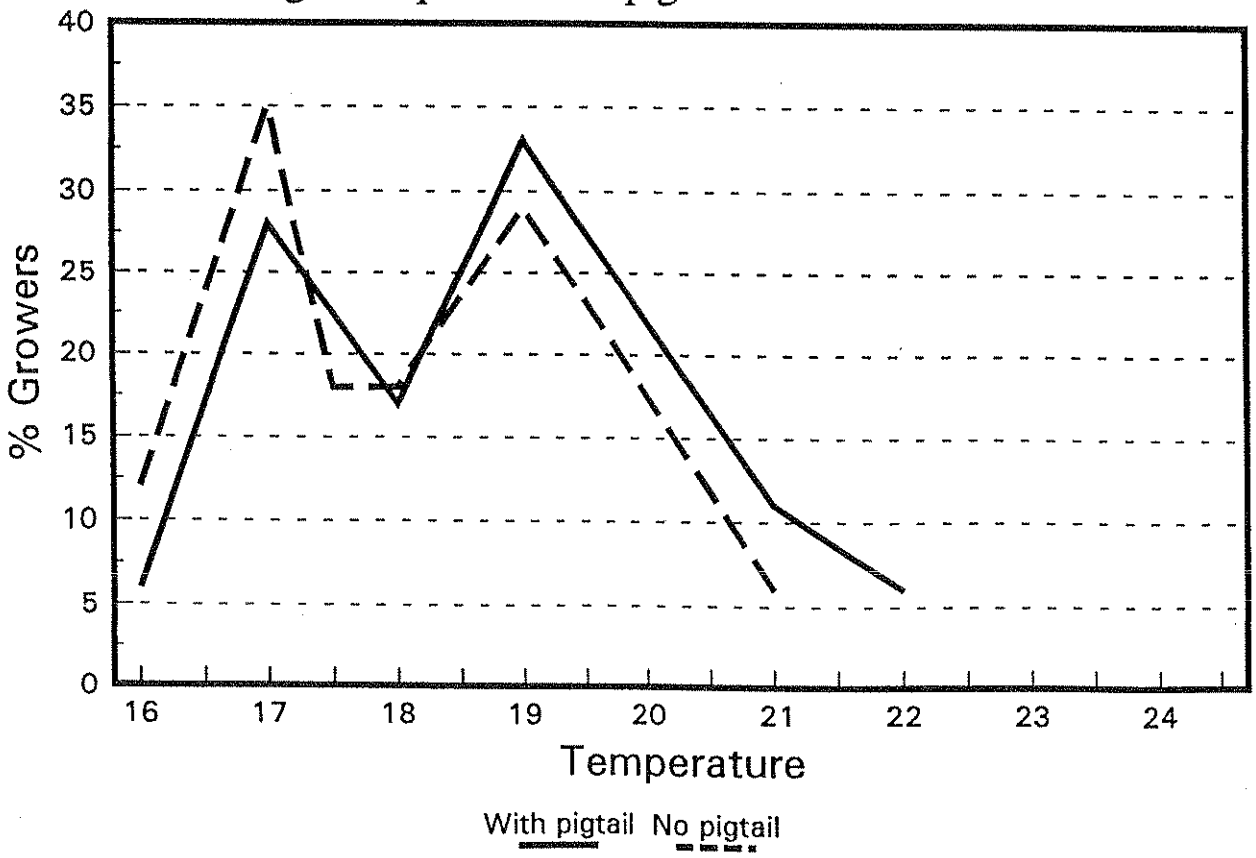


Fig.6a Effect of slab EC on pigtail.

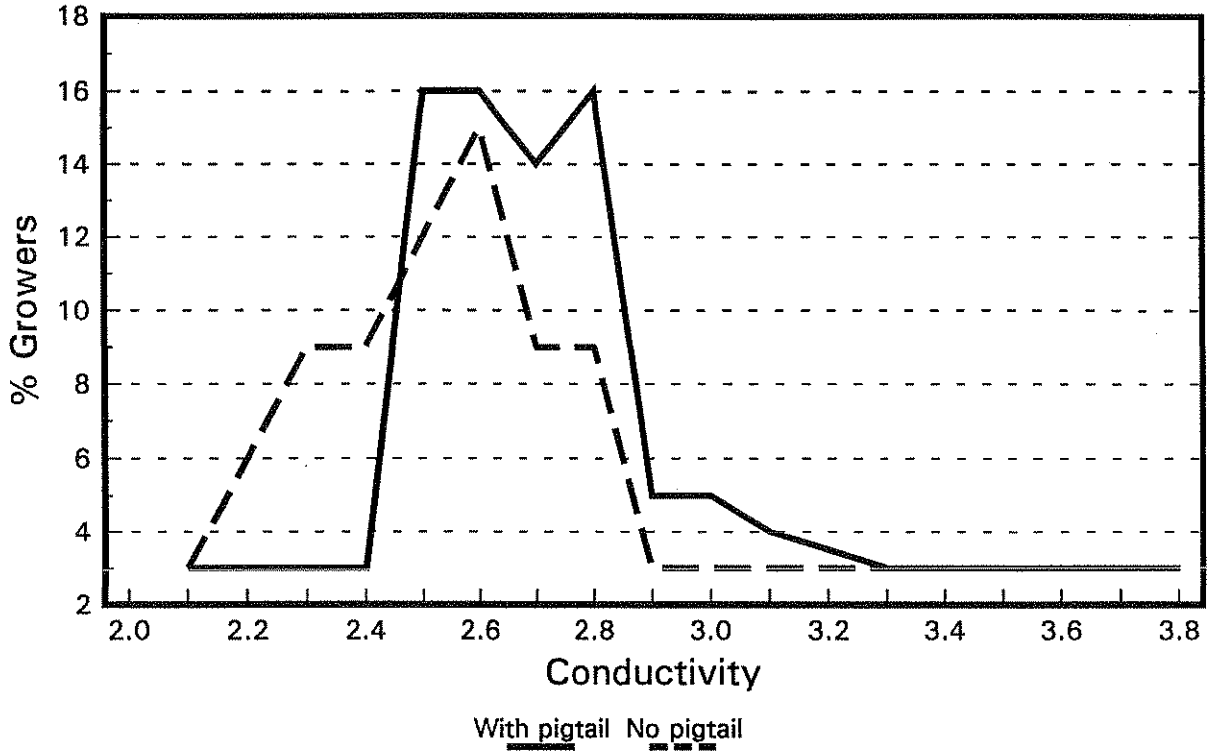
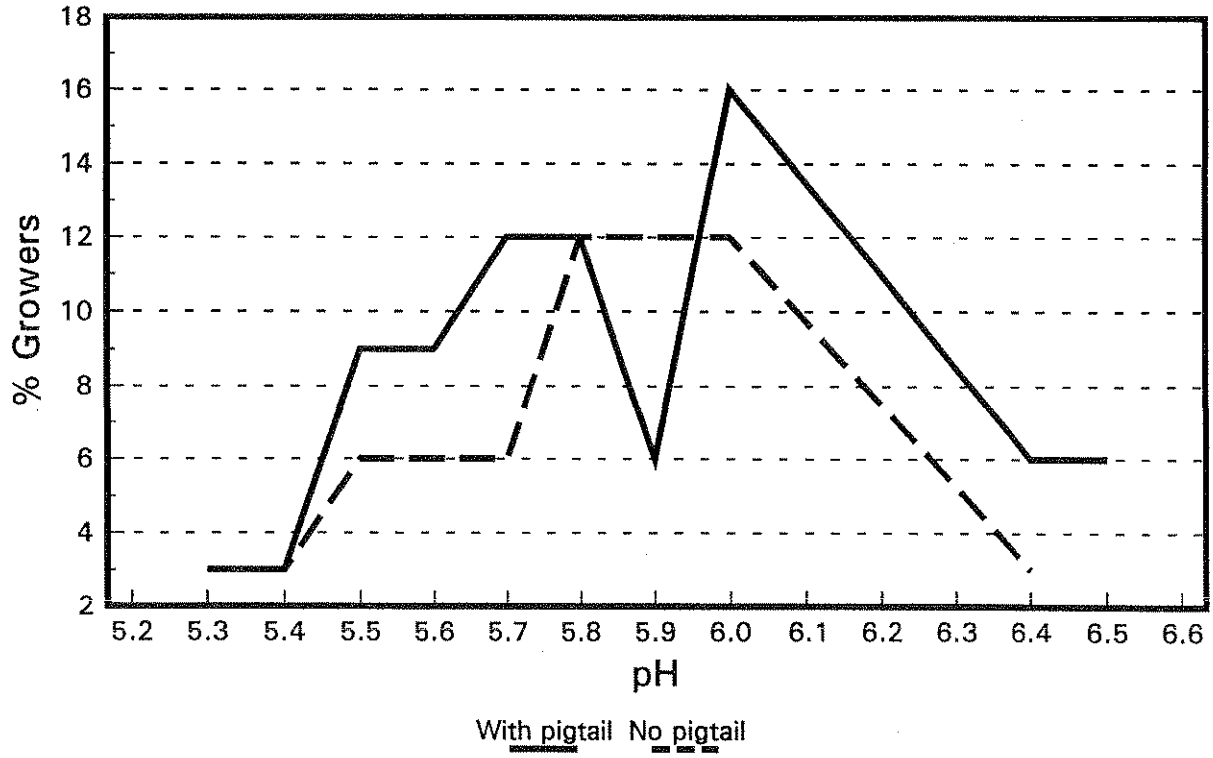


Fig.6b Effect of slab pH on pigtail



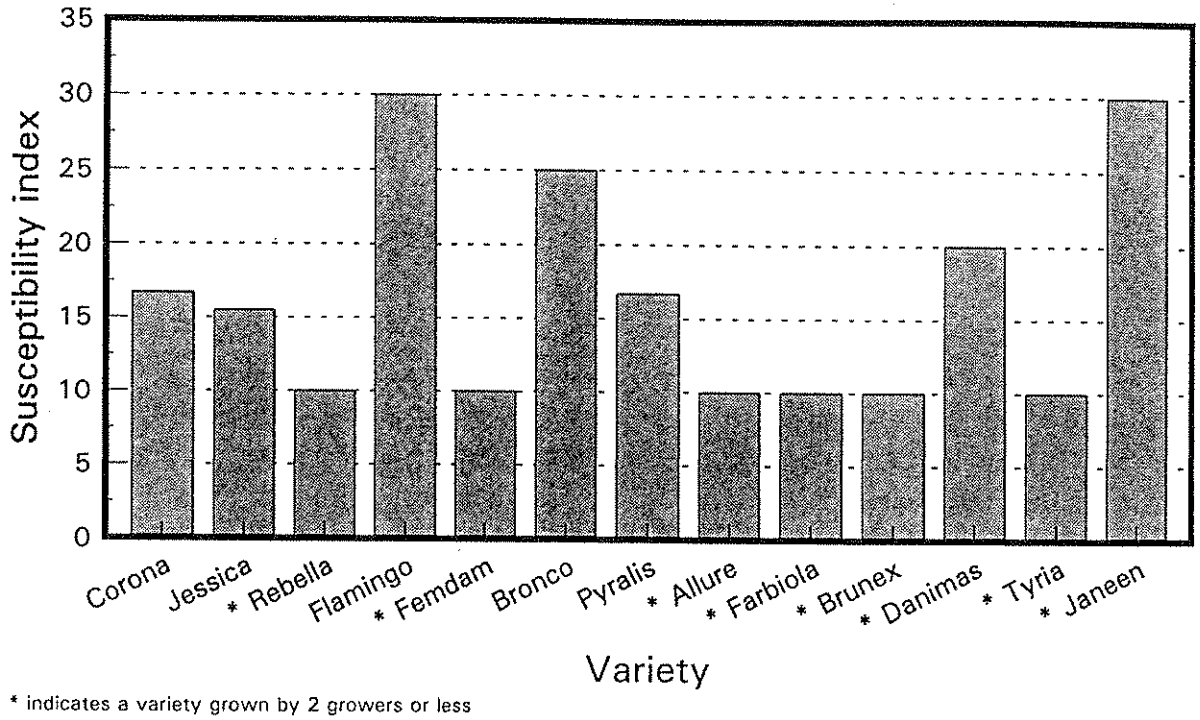
Varieties

60% of growers who grew more than one variety recorded a difference in susceptibility.

Figure 7 shows a susceptibility index for each variety reported in the survey. Flamingo and Bronco were the most susceptible of the more common varieties.

Some varieties were only grown by one or two growers and data is therefore limited.

Fig.7 Varietal susceptibility to pigtail



* indicates a variety grown by 2 growers or less

Susceptibility Index =

$$\frac{(\text{No at } 0\text{-}20^{*} \times 10) + (\text{No at } 20\text{-}40^{*} \times 30) + (\text{No at } 40\text{-}60^{*} \times 50)}{\text{Total No Growers}}$$

* Where the level of pigtail damage was 0-20%, 20-40%, 40-60%.

Training System

Pigtail was a problem for crops grown on both cordon and archway growing systems. On cordon training systems 64% of growers that responded suffered from pigtail damage at some time and on archway training system 50% were affected.

Due to the relatively small sample size for growers using the archway system and the interaction of other factors the results do not positively show any association between training system and pigtail damage.

Heating Systems

70% of growers in the survey used hot water heating systems and of these 54% suffered from pigtail damage. Of the 15% of growers that used hot air heating 80% suffered from pigtail damage.

Pests and Diseases

Pests

At the time when pigtail was a problem there were no growers without thrips in their crops. It was not always western flower thrips however and levels were often low.

There was some indication that thrips levels tended to be higher when pigtail was a problem (Figure 8), but this was not always the case.

Some growers reported higher thrips levels at times when there was no pigtail damage.

Capsids were also common at low numbers in many crops, but there was no indication that they were involved (Figure 8c).

Low levels of western flower thrips and low-medium levels of *Thrips tabaci* (onion thrips) were also recorded by growers who did not suffer from pigtail at any time during the season.

Fig.8a WFT levels in relation to pigtail damage.

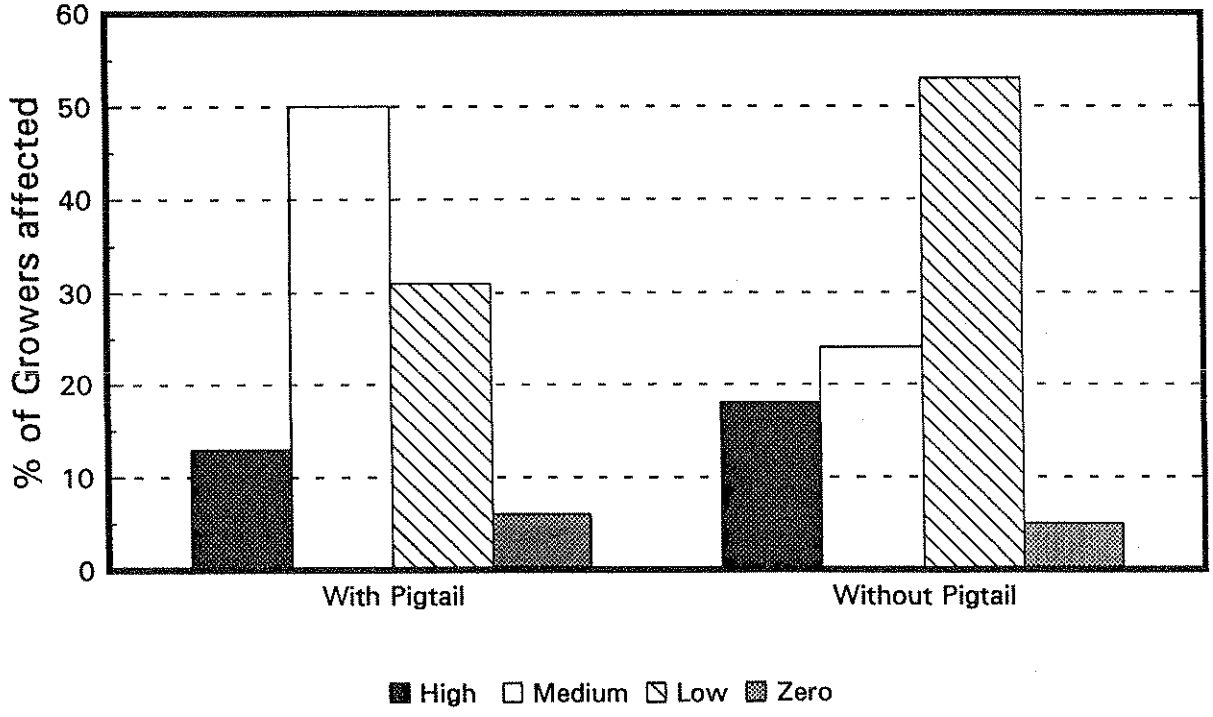


Fig.8b Onion thrips levels in relation to pigtail damage.

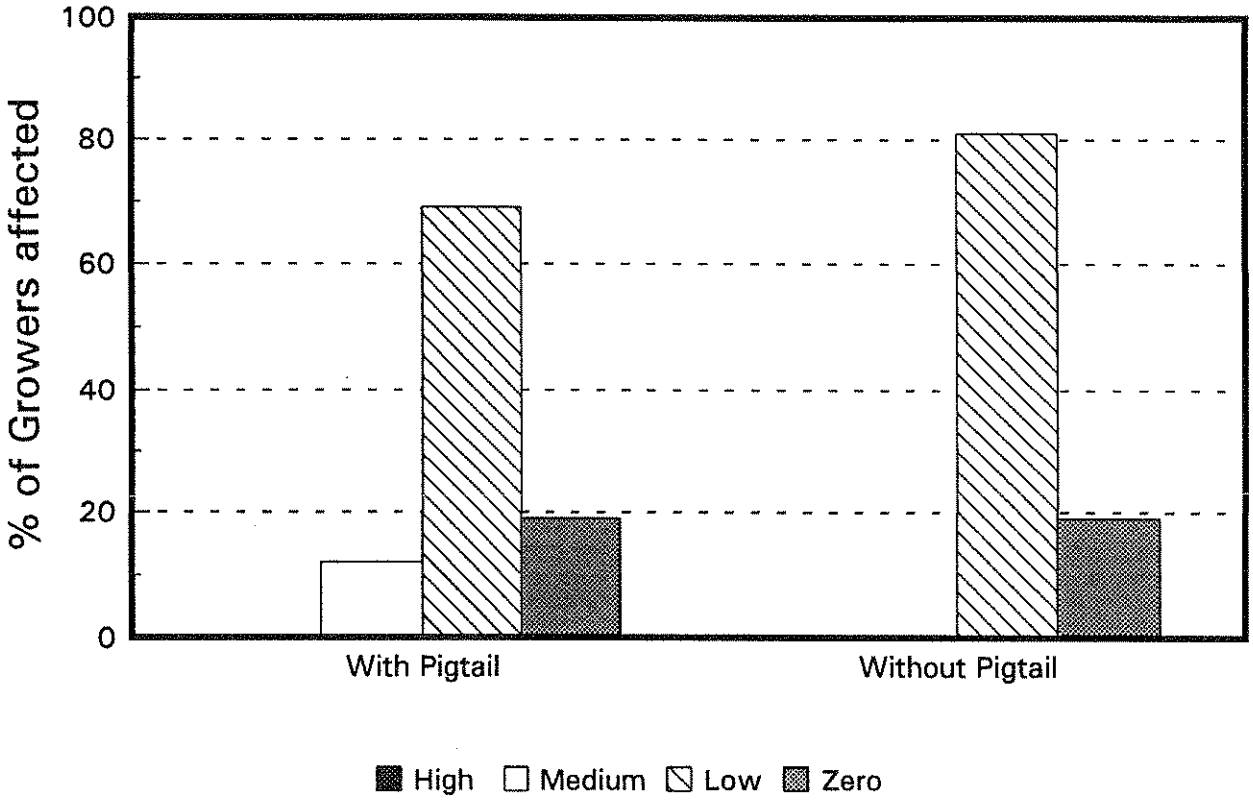
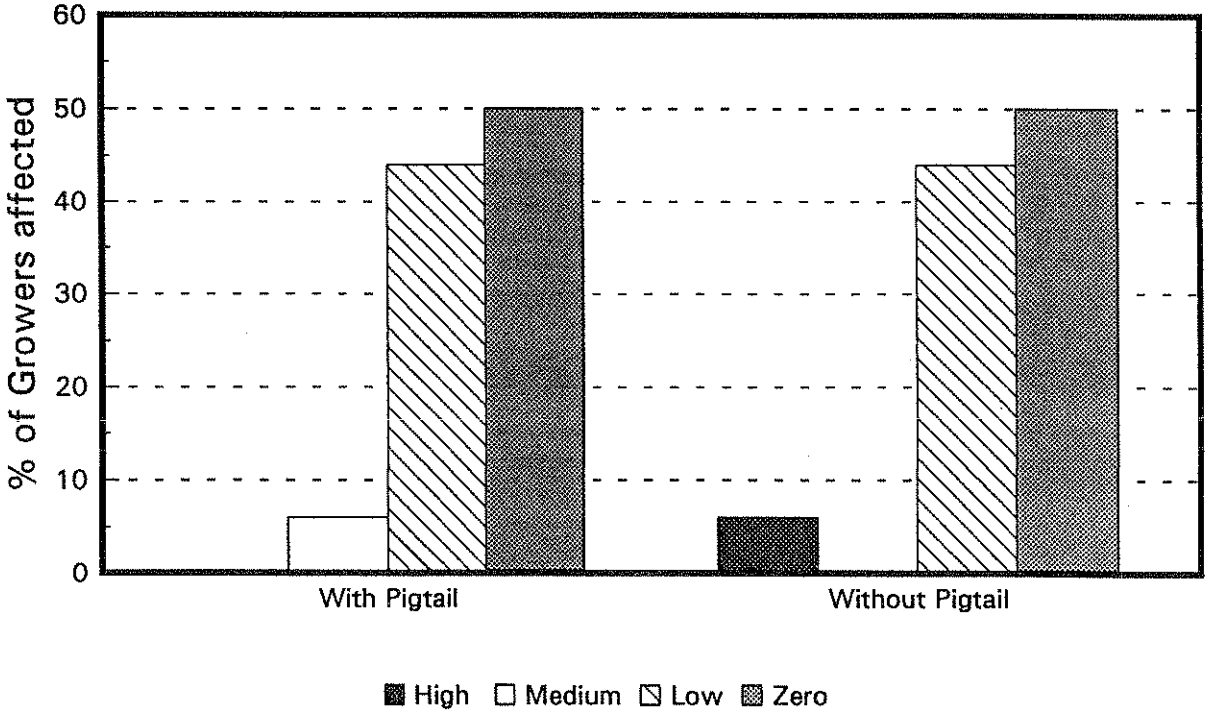


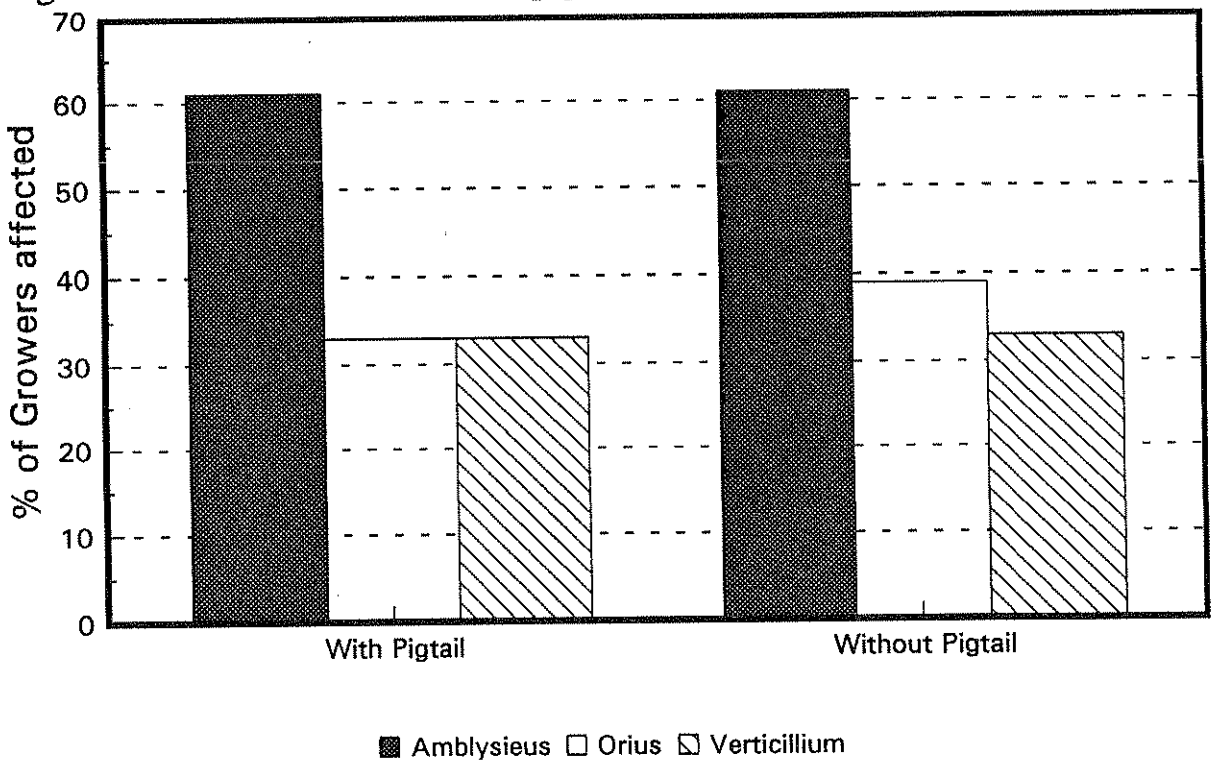
Fig.8c Capsid levels in relation to pigtail damage.



Biological Control

There was no indications that use of biological control was different during period of pigtail damage. The percentage of growers who were using Amblysieius, Orius and Verticillium was very similar both when there was damage and when the crop was unaffected (Figure 9), although numbers/levels of biological control organisms within the crop may have varied.

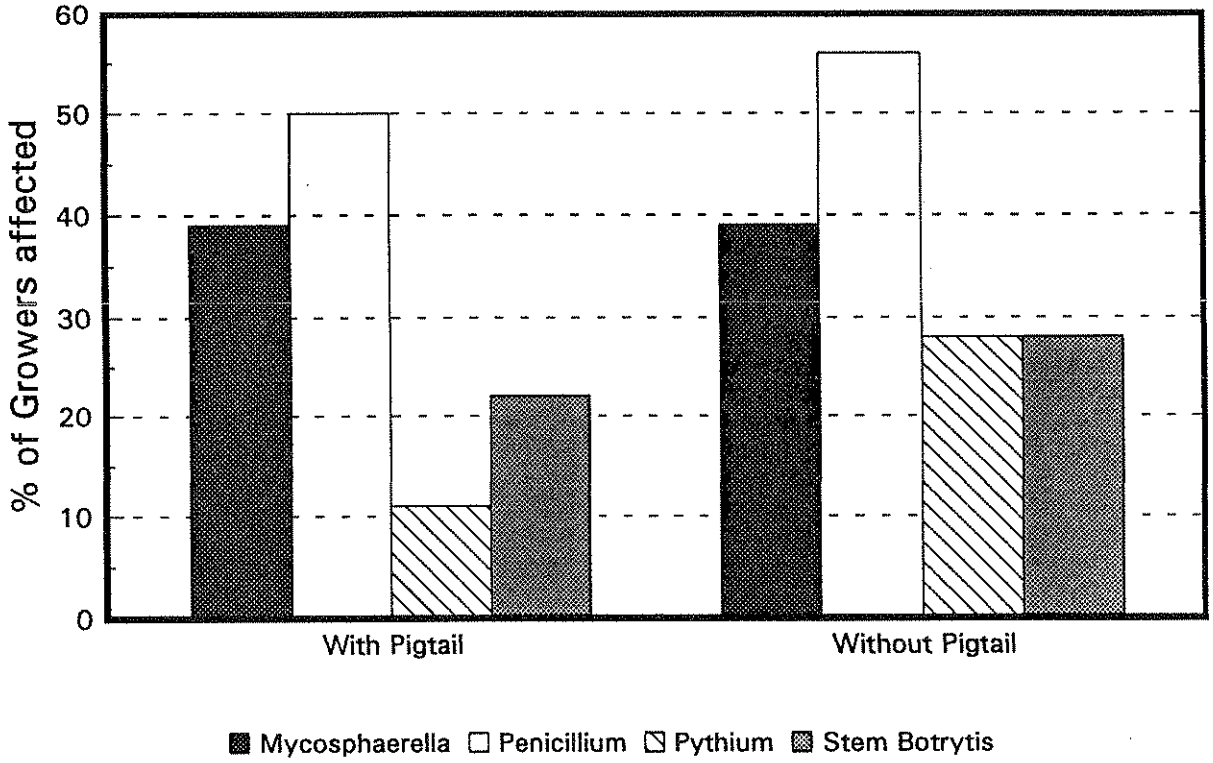
Fig.9 The effect of bio-control on pigtail



Diseases

There was as much, or more, Mycosphaerella, Stem Botrytis, Penicillium and Pythium where pigtail was not a problem as there was in affected areas (Figure 10).

Fig.10 Pigtail and disease.



Chemicals

Of the growers who suffered from pigtail damage, 82% had not regularly used any particular chemical in the two weeks before damage occurred. Of those that had used a chemical, dichlorvos was the most common.

Of those growers who suffered damage on replanted crops 64% had used dichlorvos to clean up between crops. The average number of applications was 3-4. The most common application method was air fog (67%).

Dutch Research

W. Verkerke and M Schols at the Glasshouse Crops Research Station, Naaldwijk studied the pigtail fruit syndrome of cucumber in 1992.

They suggest that the traditional theory which attributes pigtail damage to thrips is questionable. They have observed that ovary curvature may begin before a scar is seen, and microscopic examinations have shown minor injuries to the ovary surface.

At present they have not reached any conclusions on the cause of pigtail damage.

Literature Review

Pigtail in cucumbers is an area in which little detailed experimental work has been carried out and hence the literature review found no scientific references related directly to the problem.

There were however references to fruit damage caused by thrips (Rosenheim et al 1990). Densities of western flower thrips were high in flowers and fruit scarring increased with increased density. Although western flower thrips populations on fruit were low, because the small developing fruit physically supports the flower there are opportunities for them incidentally to feed on and scar young fruit.

Although it is accepted that thrips cause fruit scaring their involvement in pigtail damage is not proven (Verkerk, Schols, 1993).

Discussion

The problem seems to have become more serious from 1988 onwards, that was the year that western flower thrips was first recorded in the UK but was also the time when cropping systems began to change from single long season crops to replanting.

Levels of damage were clearly higher at certain times of the year. Replanted crops were more likely to be affected than long season, early planted crops. In particular the mainstem fruit of early planted crops was rarely affected but on summer planted crops damage was likely to be severe. This is crucial to economic cucumber production since the main reason for replanting is to obtain top quality mainstem fruit in summer. The difference could be related to the different aerial environment in the greenhouse, an increase in thrips population, choice of variety, or a combination of these factors.

Environment

The results suggested that damage was more likely to occur when growth was vigorous, but growth is likely to be vigorous during the summer period when pigtail is common.

There was some suggestion that crops with air heating were more likely to be affected than crops with pipe heat.

Training system, substrate, temperature regime or plant nutrition seemed to have no influence on pigtail levels.

Variety

Many growers who grew a range of varieties recorded a difference in susceptibility between them. Bronco and Flamingo were particularly affected.

The susceptible varieties probably have a particularly thin cuticle when they are developing which makes damage more likely.

Thrips

The question of thrips damage is clearly not straightforward. The results did show higher thrips levels where there was a pigtail problem, but there were also many growers with a thrips population and no pigtail, or higher thrips levels where pigtail did not occur.

At the beginning of the season there are relatively few thrips and no pigtail. As populations increase damage becomes more likely. Where there are very high thrips populations at replanting time there is a very high probability of damage occurring.

The results suggest that pests other than WFT can cause the problem. In some cases onion thrips were present with no WFT.

Combined Factors

Overall, the results suggest that although thrips may damage fruit they are more likely to do so under certain environmental conditions.

Early in the season a thermal screen helps to maintain humidity but later in the year relative humidity can fall at times. This is a particularly serious problem when the old crop is removed and small plants moved into the growing house. Under these conditions any thrips present in the crop, even low populations, may move into flowers and shoot tips. Feeding is then likely to affect the undeveloped fruit.

Conclusions

The survey has provided a useful guide to the extent of the problems within the UK and the losses incurred by the industry, in particular the high economic losses that can be caused by damage to the replanted crop.

The results of this survey do not provide a positive answer to the cause of pigtail in cucumber crops but eliminates some factors and suggests areas for further investigation.

1. Pigtail has become a more significant problem since 1988.

2. The level of pigtail damage increases to a peak in July and August, and it is most common on replanted crops.

3. Pigtail did not occur in crops where thrips were not present. However, very low thrips populations can be present without resulting in pigtail and conversely high thrips populations can cause severe damage. Therefore, there is no direct relationship between thrips population and level of pigtail damage.

4. Some varieties are more susceptible to damage.

5. Agronomic factors such as substrate, temperature, nutrient levels and growing system are not associated with pigtail damage, and can be elimianted from further studies.

Areas for Further Investigation

The cause of damage appears to be an interaction of cultivar, plant condition, which in turn is related to environment, and presence of thrips.

The frequency and severity of the problem show that this is an area which requires further study.

References

Rosenheim J A et al (1990). Journal of Economic Entomology, 83(4) 1519-1525. Direct feeding damage on cucumber by mixed-species infestations of Thrips palin and Franklinella occidentalis.

Verkerke W & Schols M (1993). PTG Annual Report 1992, p40-41. Characterisation of the pigtail fruit syndrome of cucumbers.

Acknowledgement

The time and trouble that many cucumber growers took in completing questionnaires is gratefully acknowledged. This report could not have been prepared without them.

APPENDIX I:

COPY OF THE QUESTIONNAIRE

PIGTAIL IN CUCUMBERS

INTRODUCTION

The term pigtail describes fruit curling in cucumbers and was a serious problem for growers in 1992.

The HDC has commissioned a review to determine the likely cause of the problem. When this is completed it will enable an experimental programme to be planned, aimed at solving the problem.

The attached questionnaire has been designed to gather information to determine which factors are linked and which can be eliminated.

Your views are very important, even if you did not see the problem.

Please complete the questionnaire and return it by 19 April in the attached envelope. Experimental work cannot begin until the information has been analysed.

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March 1993

INCIDENCE OF PIGTAIL IN CUCUMBERS DURING 1992

1. What area of cucumbers did you grow in 1992 (in acres)?

2. What substrate did you use?

Rockwool	
Soil	
Foam	
Other (specify)	

3. What training systems did you use?

Cordon		Archway	

4. What was your planting date (slab contact)?

First Crop		Replanted	

5. What is your heating system?

Steam Pipes		Hot Air	
Hot Water Pipes		Unheated	

6. In which year did you first see the problem?

19

7. What percentage of fruit was affected in 1992?

	First Crop		Replanted Crop	
	Mainstem	Laterals	Mainstem	Laterals
0–20%				
20–40%				
40–60%				
60–80%				
80–100%				

8. What was your estimated marketable yield loss?

	First Crop		Replanted Crop	
	Mainstem	Laterals	Mainstem	Laterals
0–20%				
20–40%				
40–60%				
60–80%				
80–100%				

9. In which months did you see damage?

February		March		April		May	
June		July		August		September	

10. What was the distribution of affected plants (tick one of the following)?

a. Even distribution throughout the nursery	
b. Even distribution within some blocks	
c. Scattered plants here and there	
d. Groups of plants	

11. Was the amount of damage related to:

a. Different growing environments	Yes/No
b. Different ages of glass	Yes/No
c. Different planting dates	Yes/No

If Yes, please give details:

12. Was there a difference in susceptibility between varieties?

Yes/No

13. Please list the varieties grown and tick the level to which each variety was affected (include both mainstem and lateral fruit).

Variety	0–20	20–40	40–60	60–80	80–100

14. Did damaged fruit show a scar inside the curl?

Always		Sometimes		Never	

15. What level of damage may the fruit have suffered during trimming and training operations?

a. Mainstem	Severe/Moderate/Light/Nil
b. Laterals	Severe/Moderate/Light/Nil

16. How would you describe the crop growth when Pigtail was most common?

Was the growth:	Soft/Hard	Weak/Vigorous

17. What temperature regimes were you using?

	When Damage Occurred	At Other Times
Day Set Point		
Night Set Point		

18. What was the slab conductivity & pH?

	When Damage Occurred	At Other Times
EC		
pH		

19. What numbers of the following pests were identified in your crop?

	When Damage Occurred	At Other Times
WFT	High/Medium/Low	High/Medium/Low
Onion Thrips	High/Medium/Low	High/Medium/Low
Capsids	High/Medium/Low	High/Medium/Low

20. What biological material were you using for pest control? (please tick).

	When Damage Occurred	At Other Times
Amblysieus		
Orius		
Verticillium		

21. Were the following diseases present in your crop? (please tick).

	Where Pigtail Occurred	Other Places
Mycosphaerella		
Stem Botrytis		
Penicillium		
Pythium		
Verticillium		

22. Had you always used any particular chemicals during the 2 weeks before you saw damage?

Yes/No

If Yes, please specify:

23. Was dichlorvos used in clean up between crops?

Yes/No

If Yes, how many applications?

And how was it applied?

High Volume/Air Fog

24. Please give your views on why the problem occurred and why it is so variable.

Please return your completed form to Horticulture Research International Stockbridge House in the attached prepaid envelope.

Results of the survey will be published by the Horticultural Development Council.