



**HORTICULTURE RESEARCH INTERNATIONAL**  
**STOCKBRIDGE HOUSE**

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

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Project Leader: M J Holmes

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**BEETROOT: CAUSES OF LOSS  
DURING STORAGE**

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## **Summary**

Red beet from three sites was evaluated for the cause of yield loss following barn or cold storage. The incidence and severity of diseases were monitored throughout the growth and storage period. Low levels of disease were present on all samples but common scab (*Streptomyces scabies*) was recorded at relatively high levels at Stockbridge House. Roots were assessed from store at monthly intervals from January to May 1991. No consistent differences in marketable or diseased roots were recorded between the sites in store although the highest levels of disease occurred in the machine harvesting and machine graded roots towards the end of the barn storage period.

## **Introduction**

Beetroot is required for fresh market and processing all the year round. Prices can be considerably higher during the period March to June. Considerable investigation during the 1970's at Luddington EHS (A C W Davies, 1974/75) produced guidelines for storage. Recently however, diseases in store have resulted in loss of yield and income. The initial purpose of this investigation was to examine different systems of storage and the effects of harvesting and grading on yield loss and monitor the incidence of diseases.

## **Objective**

To evaluate harvesting and grading techniques and storage systems and to assess their effect on the incidence and severity of diseases in store.

## **Materials and Methods**

Site: **HRI Stockbridge House, Cawood, Selby, N Yorkshire YO8 0TZ.**

Roots for storage were also from the commercial farms of:  
**Greens of Soham, 50 High Street, Ely, Cambs CB7 5HF.**  
**S T Holmes Ltd, Trent Farm, Hemdyke House, Owston Ferry, Doncaster, S Yorkshire.**

## Treatments

### Storage

Cold store at Stockbridge House

Barn store at Stockbridge House

Clamp store at S T Holmes (samples sent to Stockbridge House for assessment)

### Field Sites

Samples were put into the cold and barn stores at Stockbridge House from field sites at:

Stockbridge House - No Salt

Stockbridge House - With Salt

Greens of Soham

S T Holmes Ltd

### Harvest Method

At each field site three harvest methods were used:

Harvested by machine, no grading

Harvested and graded by machine

Harvested and graded by hand

Cultural Details at HRI Stockbridge House

Variety: Crimson Globe (Elsoms)

Base Dressing: No Salt; 105:42:75 kg/ha NPK  
With Salt at 400 kg/ha; 90:90:90 kg/ha NPK

Drilled: 25 May  
Target Density; 150 plants/m<sup>2</sup>

Top Dressing: 26 June, 145 kg/ha N

Pest and Weed Control: As standard commercial practice.  
No fungicides were applied to the crop.

Harvested and Graded: 15-19 October according to treatments and put into store.

Design: The crop was grown in the field as a single block. The beetroot for storage were selected at random from the field. 100 roots per treatment in 2 nets. Treatments were randomised throughout bins for cold store and stack for barn stored. Guard roots were placed around each treatment net.

<u>Removal Dates</u>	<u>Cold Store</u>	<u>Barn Store</u>	<u>Clamp</u>
Assessment 1	16 January	16 January	16 January
Assessment 2	27 February	27 February	27 February
Assessment 3	25 March	25 March	25 March
Assessment 4	23 April	23 April	*
Assessment 5	22 May	-	*

\* Clamp finished after third assessment.

Records

Assessments After Removal from Storage at Each Date:

Marketable

Damaged

Diseased excluding common scab

Common scab

Withered

Disease identification was carried out by Dr M McPherson, ADAS Leeds.

Statistical Analysis

Analysis carried out as a standard analysis of variance.

## Results

**Table 1: Percentage of Marketable and Diseased Roots in Each Storage Technique (angle transformation) - See Appendix: Table 7 for Actual Percentage**

Store	Marketable			Diseased*		
	16 Jan	27 Feb	25 Mar	16 Jan	27 Feb	25 Mar
<u>Cold</u>						
SH No Salt	60	51	52	5.5	16.7	5.1
SH Plus Salt	46	52	40	6.0	12.1	6.0
Greens	75	68	49	4.6	10.4	17.3
Holmes	73	72	64	11.7	13.2	17.5
<u>Barn</u>						
SH No Salt	64	60	50	8.8	14.0	7.8
SH Plus Salt	58	55	47	12.1	16.6	11.7
Greens	75	64	55	5.4	8.6	6.5
Holmes	78	68	52	7.8	7.2	11.1
<u>Clamp</u>						
Holmes	66	76	58	13.2	6.2	9.8
SED (16 df)	5.4	5.4	5.4	3.39	3.39	3.39

\* Diseased roots excluding common scab and withered

### Marketable Roots

No consistent differences in the percentage marketable roots were recorded with the different methods of storage. The percentage of marketable roots tended to decline with longer storage, especially from the commercial sites.

### Diseased Roots (excluding common scab and withered)

Root diseases were present in all treatments. Although the incidence varied, there were no consistent differences between any of the treatments.

**Table 2: Effect of Harvesting System\* on Percentage of Marketable Roots in Storage (angle transformation) - See Appendix: Table 8 for Actual Percentage**

<u>Cold Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	22 May
Harvested by machine - No grading	59	59	45	65	58
Harvested & graded by machine	68	59	50	63	68
Harvested & graded by hand	65	64	58	68	61
SED (6 df)	4.6				
<u>Barn Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	
Harvested by machine - No grading	64	60	56	63	
Harvested & graded by machine	69	66	46	55	
Harvested & graded by hand	74	59	52	62	
SED (6 df)	4.6				

\* Mean of the four field site treatments

There were no consistent differences of the number of marketable roots between harvest treatments or the length of time in store. The only exception was where roots were harvested and graded by machine and subsequently stored. From March to April there were fewer marketable roots compared with January to February assessments but differences were not always significant.

**Table 3: Effect of Harvesting System<sup>+</sup> on Percentage of Roots with Disease\* in Storage (angle transformation) - See Appendix: Table 9 for Actual Percentage**

<u>Cold Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	22 May	SED
Harvested by machine - No grading	7.9	14.9	10.4	16.2	15.1	
Harvested & graded by machine	7.4	13.1	14.7	19.2	13.3	3.09
Harvested & graded by hand	5.5	11.4	9.3	11.8	13.6	
SED (8 df)		3.09				
<u>Barn Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	SED	
Harvested by machine - No grading	10.4	10.6	8.7	15.8		
Harvested & graded by machine	9.8	13.2	11.3	23.6	2.28	
Harvested & graded by hand	5.4	11.0	7.9	16.0		
SED (6 df)		2.28				

\* Excluding common scab and withered

+ Mean of the four field site treatments

There were few consistent differences between treatments of percentages of diseased roots following barn and cold storage.

Harvesting and grading by hand tended to reduce the incidence of disease roots compared with harvesting by machine or harvesting and grading by machine but it was only significant at the April assessments.

Harvesting and grading by machine tended to increase the incidence of root diseases in barn storage, but it was only significant over the other two treatments at the April assessment



**Table 4: Percentage of Roots with Common Scab (angle transformation) (actual ( )). Means of storage and harvest methods**

	% Roots with Common Scab	
<u>Stockbridge House</u>		
No Salt	19.1	(13.9)
Plus Salt	23.5	(19.8)
<u>Greens</u>	6.5	(3.0)
<u>Holmes</u>	2.6	(1.1)
SED (48 df)	1.55	

The percentage of roots with common scab was significantly higher at Stockbridge House compared to the commercial sites.

**Table 5: Percentage of Damaged Roots Means of storage and field treatments (angle transformation) (actual ( ))**

	% Damage	
Harvested by machine - No grading	10.6	(5.1)
Harvested and graded by machine	10.6	(5.7)
Harvested and graded by hand	5.2	(2.4)
SED (64 df)	1.14	

The roots harvested and graded by hand had the lowest incidence of damage. For machine harvesting there was no difference in the percentage of roots damaged from graded or ungraded treatments.

**Table 6: Percentage of Withered Roots**  
**Mean of four assessments (angle transformation) (actual ( ))**

	Stockbridge House			
	No Salt	Plus Salt	Greens	Holmes
Cold Storage	12.1 (7.8)	12.2 (9.9)	4.6 (4.3)	1.2 (0.3)
Barn Storage	9.7 (6.1)	12.3 (12.3)	14.9 (10.6)	13.0 (8.8)
SED (24 df)	3.05			

The barn storage treatment increased the incidence of withered roots compared with cold storage at the two commercial farms although not at Stockbridge House. In contrast, cold stored roots from the two commercial farms reduced the percentage of withered roots as compared with those from Stockbridge House.

## Discussion

In theory the number of marketable roots at the monthly assessments would be expected to decrease towards April and May but this did not occur consistently in this experiment. Root diseases were monitored in the field and in storage. Common scab was the main disease present in the field, with the highest incidence at Stockbridge House. Levels of other diseases although tending to be lower at the first assessment and higher at the later assessments, generally did not alter greatly throughout the storage period. The main pathogens identified were *Phoma lingam*, *Botrytis cinerea*, *Fusarium* spp and a *Cylindrocarpon* sp. Secondary fungi were also found eg; *Geotrichum* sp and *Rhizopus* sp.

Apart from the high incidence of common scab at Stockbridge House differences in disease levels were not consistent or significant between the field sites or following crop treatment with salt. However it was noted that various diseases, although at low levels, were found in all samples. Irrespective of harvesting or storage method primary sources of infection were present when the crop was put into store. The 1991 season was dry and not particularly conducive to rapid disease build up. Different weather conditions during growth in the field and in storage, especially clamp or barn storage, could in other years encourage infection and spread of several root pathogens found at low levels in 1991.

Although the number of damaged roots from the machine harvested treatments was double that of the hand harvested and graded treatment, the increased damage did not have a great impact on disease levels. The comparatively large number of withered roots was probably due to edge effect caused by increased air flow around the nets that kept treatments separate in store.

## **Conclusions**

A range of primary root diseases at low levels were present on roots in the field from all sites and were a source of infection during storage, irrespective of harvesting method.

Secondary fungi were also identified on roots in store. These appeared to colonise damaged or previously diseased roots.

Although machine harvesting and grading increases the incidence of root damage, it did not necessarily promote disease in this trial.

## **Future Work**

The work should continue and treatments should include methods of preventing primary infection and disease development in the field. There is a need to positively identify the primary pathogens responsible for storage diseases, assess their incidence, severity and potential for spread in store.

Future treatments should include the application of broad-spectrum fungicides in the field and as pre-storage dips/drenches and to evaluate their effectiveness in the prevention/control of losses in store.

## **References**

- Davies, A. C. W. (1974). Red Beet storage experiment. 25th Annual Report, Luddington EHS.
- Davies, A. C. W. (1975). Beet Red storage at different temperatures. 26th Annual Report, Luddington EHS.

## **Acknowledgements**

The identification of disease by Dr M McPherson, ADAS Leeds is gratefully acknowledged. Also the cooperation and collaboration of Greens of Soham and S T Holmes Ltd.

APPENDIX I

**Table 7: Percentage (actual) of Marketable and Diseased Roots in Each Storage Technique**

Store	Marketable			Diseased		
	16 Jan	27 Feb	25 Mar	16 Jan	27 Feb	25 Mar
<u>Cold</u>						
SH No Salt	74	60	63	3	8	2
SH Plus Salt	52	62	41	2	5	2
Greens	92	86	56	2	4	9
Holmes	91	88	79	4	8	10
<u>Barn</u>						
SH No Salt	76	74	59	3	6	3
SH Plus Salt	71	65	54	6	9	5
Greens	92	80	67	2	4	2
Holmes	93	84	62	3	3	5
<u>Clamp</u>						
Holmes	83	92	72	6	2	5

**Table 8: Percentage (actual) of Marketable Roots in Storage After Harvesting Systems**

<u>Cold Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	22 May
Harvested by machine - No grading	71	71	50	81	70
Harvested & graded by machine	85	73	59	78	85
Hand harvested & graded	76	78	70	83	74
<u>Barn Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	
Harvested by machine - No grading	77	74	68	79	
Harvested & graded by machine	85	83	52	66	
Hand harvested & graded	88	71	61	77	

**Table 9: Percentage (actual) of Roots with Disease in Storage After Harvesting Systems**

<u>Cold Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	22 May
Harvested by machine - No grading	3.2	6.8	4.8	8.7	10.0
Harvested & graded by machine	2.8	7.3	7.3	12.5	7.3
Hand harvested & graded	2.0	5.3	4.8	6.9	6.9
<u>Barn Store</u>	16 Jan	27 Feb	25 Mar	23 Apr	
Harvested by machine - No grading	3.9	4.7	3.4	9.5	
Harvested & graded by machine	4.3	5.8	4.5	17.5	
Hand harvested & graded	2.0	6.3	2.9	10.4	