SHELF LIFE TESTING

ON

LETTUCE

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SHELF LIFE TESTING - THE EFFECT OF HEAD MATURITY AND HEAD DENSITY ON THE POST HARVEST QUALITY OF ICEBERG LETTUCE

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Abstract

Many factors affect the post harvest quality of iceberg lettuce but head density at the time of harvest was thought to play a particularly important role. This trial was therefore designed to fully investigate the effect of head density on quality during a period of shelf life in conditions of 20°C, 50% RH.

Three crops of iceberg lettuce were grown at Luddington EHS and sequential harvests taken as soon as heads were starting to bulk up. Each harvest was carefully monitored through a 72 hour shelf life period, at the end of which heads were cut open and internal assessments taken.

Results indicated that harvesting heads at a higher density (greater than 6) led to a reduction in weight loss and better turgidity ratings during shelf life, but also led to higher levels of internal and external disease and to a more rapid deterioration of the butt.

Objective

To determine the optimum density at harvest for maximum shelf life quality of iceberg lettuce and to assess the effect of maturity on post harvest quality.

Introduction

Previous trials on iceberg lettuce have assessed the effects of a range of film overwraps/bags on post harvest quality and have also evaluated the effect of nitrogen.

Work in the third year of this project has concentrated on the effects of head density and maturity. The two factors are closely related, although distinct, since a head of given density could be produced by lettuce of vastly different maturities, depending on the conditions during growth.

The trials have been designed to closely follow individual heads through shelf life and so relate shelf life to density/maturity characteristics.

Materials and Methods

The trial was repeated three times on different crops of lettuce.

Treatments

1. Heads harvested immature (approximate head density 3)
2. Heads harvested mature (approximate head density 5)
3. Heads harvested slightly overmature (approximate head density 7).

The outline cultural details for each trial were as follows:

Trial:	1	2	3
Variety:	Kelvin	Saladin	Saladin
Sown:	11/4	24/4	14/6
Planted:	10/5	22/5	26/6
Spacing:	All trials were 4 rows, 380 mm apart, on 1.83 m bed with 305 mm between plants in row		
Herbicide:	(Kerb 50W) 16/5	(Kerb 50W) 22/5	(Kerb 50W) 28/6
Pesticide:	Aphox/Ambush C 5/6	Aphox/Ambush C 5/6	Metasystox 28/6 Malathion 21/8
Harvest 1	19/6	30/6	7/8
2	22/6	6/7	11/8
3	26/6	11/7	15/8

Harvests were made when the average head density in a plot had reached the required level. At each harvest 40 consecutive Class I heads were cut. Heads were disregarded if rendered Class II or unmarketable by any characteristic other than density.

Harvesting for all trials took place between 09.00 to 10.00 hours. The lettuce were then transported from the field to the packing shed, and overwrapped in PY8 polypropylene film and individually numbered. At 14.00 hrs the heads were vacuum cooled to 3^{o}C and transferred to the shelf life room (20^{o}C, 50% RH). Individual heads were monitored over a 72 hour period.

Assessments

The following records were taken:

Weight loss during cooling (bulked samples only); weight loss during shelf life. Disease, turgidity and butt condition scored on a 9-0 scale, where 9 = excellent, after 0 and 72 hours shelf life.

At the end of shelf life, all heads were split open and internal density scored on a 1-9 scale (see Appendix I) where 9 = very dense. The length of the internal stalk was similarly assessed.

Statistical analysis

This was undertaken by Mr A Mead, IHR Wellesbourne. Regression analysis on each shelf life characteristic was carried out to establish the effect of head density (as measured at the end of the trial) on shelf life quality. Analysis using individual head scores did not produce meaningful results so results from meaned replicate plots (40 heads) were used instead.

Results

The range in meaned head densities from the replicated plots from each harvest are detailed in Table 1. In almost all harvests, heads were slightly less dense than the estimated level. In particular, the first and second harvests of Saladin I were very loose.

Table 2 details the internal stalk development in all plots. Both crops of Saladin grew through a period of relatively high temperatures. In particular, the second crop did not mature and heart up in a typical manner, hence although head densities were not very high, the lettuce was very mature, as indicated by the extended internal stalk.

Table 1 Head densities, scored 9-0, where 9 = very dense

Harvest	Range in density scores		
	Kelvin I	Saladin I	Saladin II
Harvest 1	2.8-3.3	2.1-2.4	3.1-3.4
Harvest 2	4.1-5.0	3.0-3.7	4.6-5.0
Harvest 3	6.1-6.6	5.8-6.3	6.1-6.9

Table 2 Internal stalk development, scored 9-0, where 9 = very little extension, after 72 hours shelf life

Harvest	Range in internal stalk Kelvin I	Saladin I	Saladin II
Harvest 1	N/A (approx 9.0)	7.96	5.70
Harvest 2	8.74	7.76	3.87
Harvest 3	7.52	6.96	3.42

Percentage weight loss

In both the first and last trials (Kelvin I and Saladin II) results indicated a trend of decreasing weight loss as head density increased. In both trials the trend (significantly greater than 0) was further increased as shelf life progressed (graphs 1 and 2). In the first trial after 72 hours shelf life a one unit increase in density resulted in a reduced 0.43 per cent weight loss (SE 0.030, 7 df). In the later trial the reduction was only 0.28 per cent (SE 0.013, 7 df).

These trends were not apparent in the second trial (Saladin I). No differences in weight loss were evident early in the shelf life of this crop. After 72 hours however there is a suggestion that the second harvest (density 3.0-3.7) lost least weight (Table 3).

Table 3 Regression analysis of percentage weight loss after 72 hours shelf life. Trial II (Saladin I)

Harvest	% wt loss observed and fitted values (meaned over 4 reps)	
H 1	3.81	S.E = 0.495 ns
H 2	2.62	
H 3	3.74	

Disease levels

Overall, very little disease at all developed on Kelvin in the first trial. There were no differences after 0 and 24 hours shelf life. After 72 hours shelf life the heads from the third harvest (density 6.1-6.6) had developed more disease than the early ones (Table 4).

Table 4 Regression analysis of disease scores, scored 9-0, where 9 = excellent, after 72 hours shelf life. Trial I (Kelvin)

Harvest	Disease score observed and fitted values (meaned over 4 reps)	
H 1	8.80	S.E = 0.059** (6 df)
H 2	8.89	
H 3	8.54	

Results from the second and third trials are clearly illustrated in graphs 3 and 4.

In general higher density heads developed more disease. In the second trial (graph 2), the slope of the regression line was -0.110 (significant from 0; 0.031 SE; 7 df) after 0 hours, -0.283 (significant from 0; SE of 0.043, 3 df) after 24 hours and -0.509 (significant from 0, SE of 0.051, 7 df) after 72 hours.

The third trial using Saladin again indicated a similar trend except that disease levels in heads from the first and second harvests (densities 3.1-3.4 and 4.6-5.0) were very similar. The higher density heads (6.1-6.9) again developed more disease (graph 4).

Turgidity

Turgidity scores relate to a visual and hand felt assessment of crispness. As such it provides an indication of freshness as perceived by the consumer.

In the three trials there was an increase in turgidity scores as head density increased. In the first trial (Kelvin I) heads harvested on the second and third occasions (density >4.0) scored very similarly (graph 5).

For both the Saladin trials regression analysis indicated a significant trend (significant from 0) of decreasing turgidity scores with decreasing density.
Saladin I (second trial) the slope of the line after 72 hours was 0.129 (SE 0.024, 7 df) whilst in the third trial (Saladin II) it was 0.222 (SE 0.021 7 df) (graphs 6 and 7).

Butt condition

The condition of the lettuce butt is not a particularly important quality attribute but it can be used as another indicator of freshness. Badly discoloured or rotting butts are unsightly and suggest to the consumer that the lettuce was harvested some time ago. Previous experience has indicated that the rate of deterioration of lettuce butts does vary with a number of factors.

In the crop of Kelvin, condition of the butts from the second harvest (density 4.1-5.0) retained the best score throughout shelf life. Butts of the later harvested heads (density 6.1-6.6) started well but deteriorated rapidly. Those from the very early harvest retained a very similar ranking throughout (Table 5).

Table 5 Regression analysis of butt scores after 72 hours shelf life. Trial I (Kelvin)

Harvest	Butt scores observed and fitted values (meaned over 4 reps)	
0 hrs shelf life		
H 1	8.13	SED = 0.059 *** 6 df
H 2	8.90	
H 3	8.72	
24 hrs shelf life		
H 1	7.32	SED = 0.111 *** 6 df
H 2	7.59	
H 3	6.96	
72 hrs shelf life		
H 1	6.79	SED = 0.115 * 6 df
H 2	7.08	
H 3	6.66	

The first crop of Saladin showed a similar rapid deterioration of the butts from higher density heads (harvest 3) (graph 8). The early harvested lettuce butts also deteriorated but less rapidly than later harvests.

Similarly in the second crop of Saladin the denser heads followed the same pattern of scoring high initially but deteriorating rapidly thereafter (graph 9).

Internal disease

Internal disease scores reflect the extent of any internal break down. It was only recorded on the two crops of Saladin. In both, crop levels on the highest density heads were higher than on the less dense lettuce (graphs 10 and 11).

Conclusions and Discussion

There has been a trend in the multiples over the last few seasons to reduce the head density specification for iceberg lettuce. Very dense, tightly packed heads are no longer desirable.

Results from the detailed analyses in these trials support the move since higher density trends (density greater than 6) tended to develop higher levels of both internal and external breakdown and also suffered a more rapid deterioration of the butt.

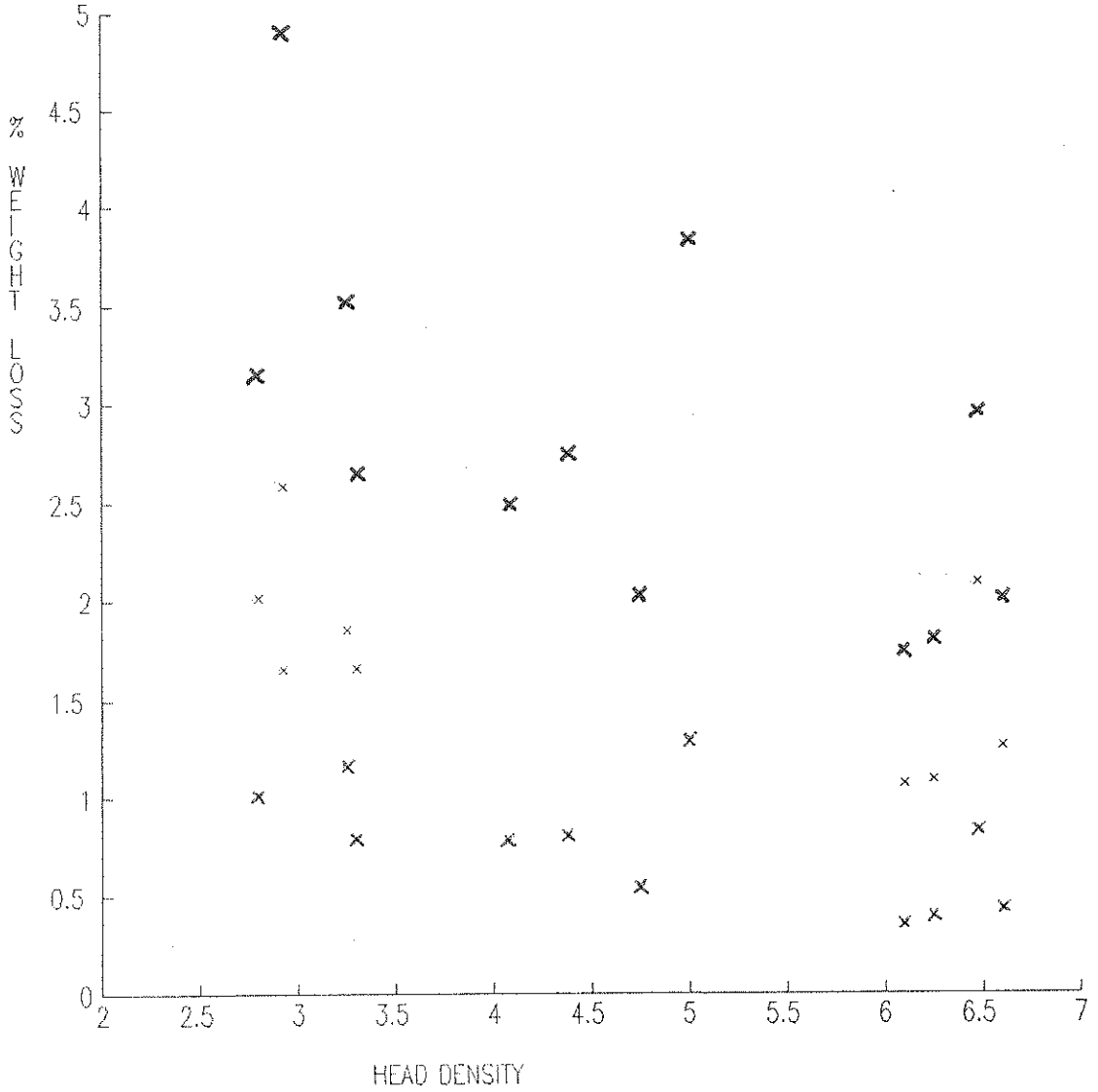
Harvesting less dense heads did lead to higher weight loss and reduced turgidity but intermediate densities presented a compromise, optimising all post harvest characteristics.

Future action

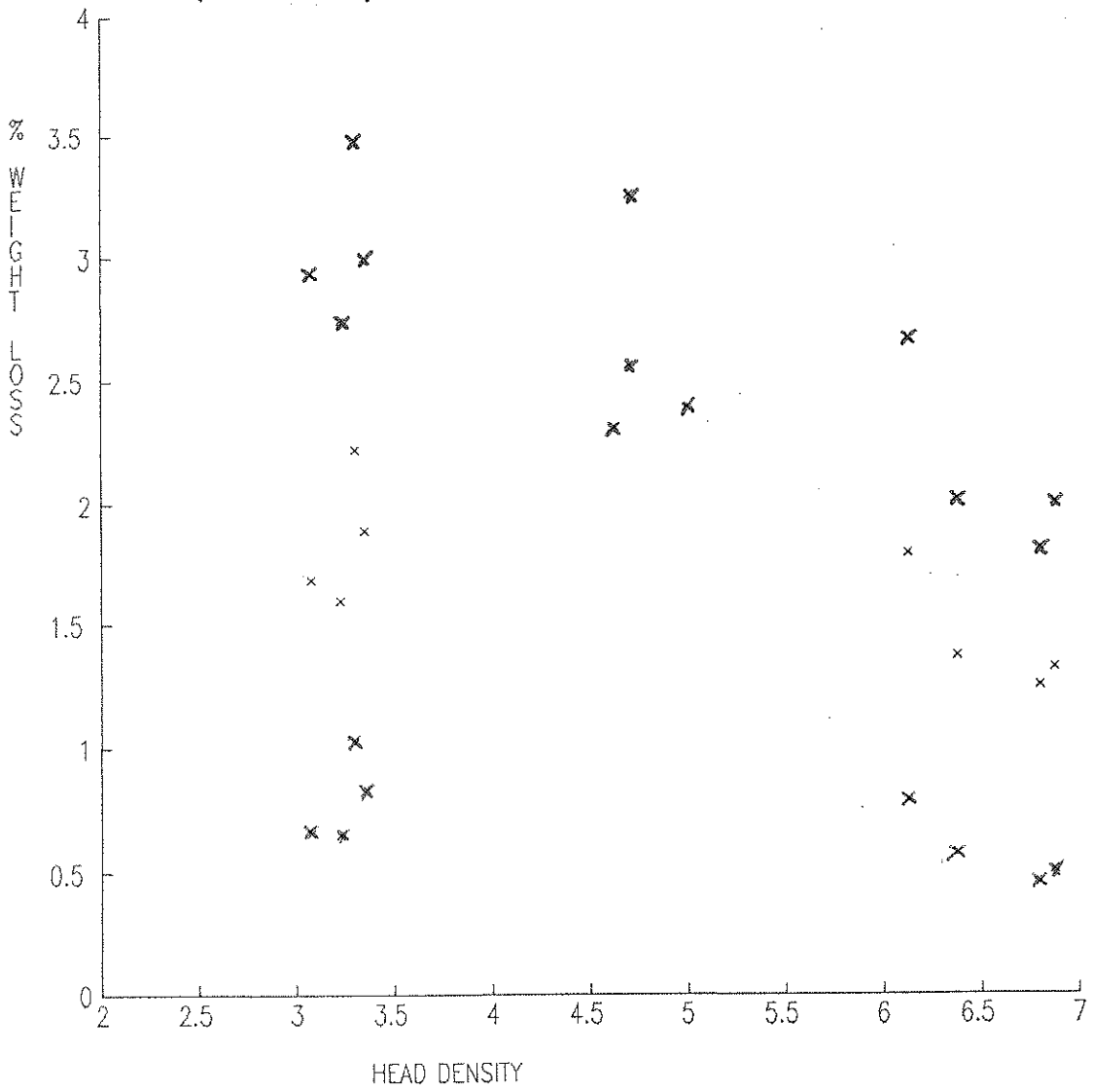
Post harvest work at Luddington ceases with the closure of the Station in November 1989. This work represents the first year of work investigating the relationship between post harvest quality and lettuce head density. The experience has enabled suggestions for improved trials if work were to be continued. The relationship between maturity, head density and post harvest quality has not been resolved. Future work should include sensory analysis.

Graph 1 Regression analysis of percentage weight loss throughout shelf life

Trial 1 (Kelvin)

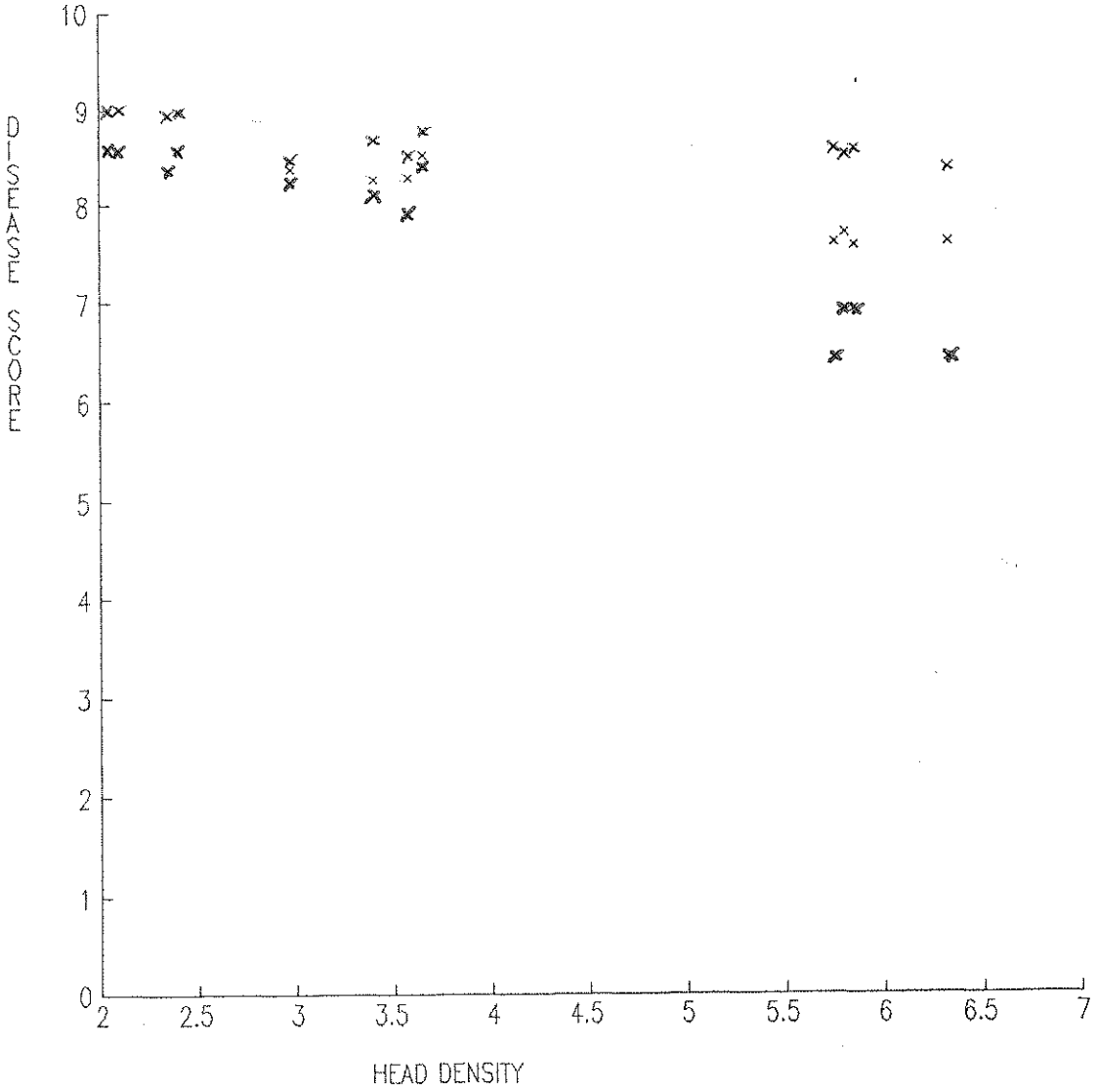


Graph 2 Regression analysis of percentage weight loss throughout shelf life
Trial 3 (Saladin II)



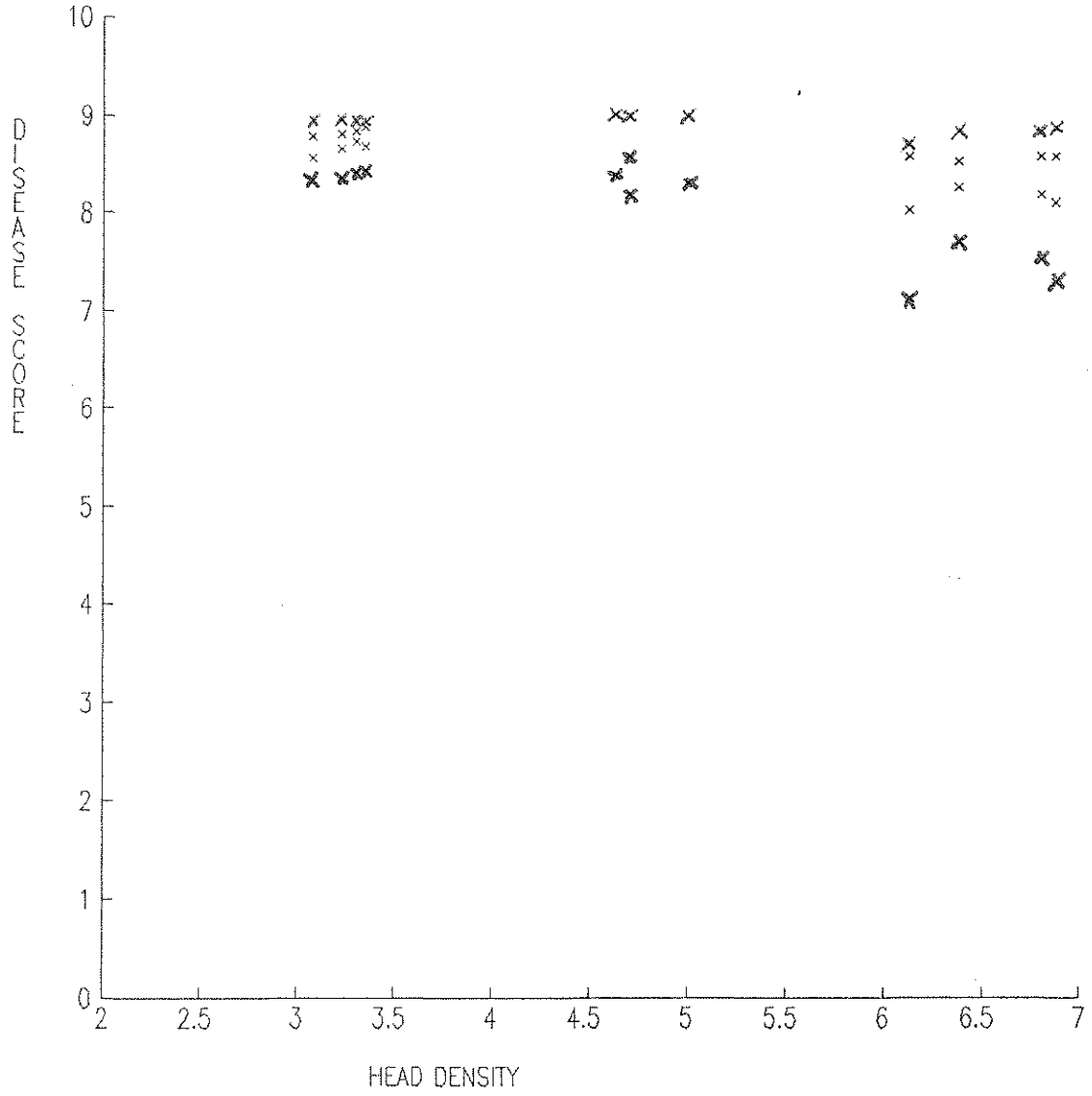
Graph 3 Regression analysis of disease scores throughout shelf life (where 9 = excellent)

Trial 2 (Saladin I)



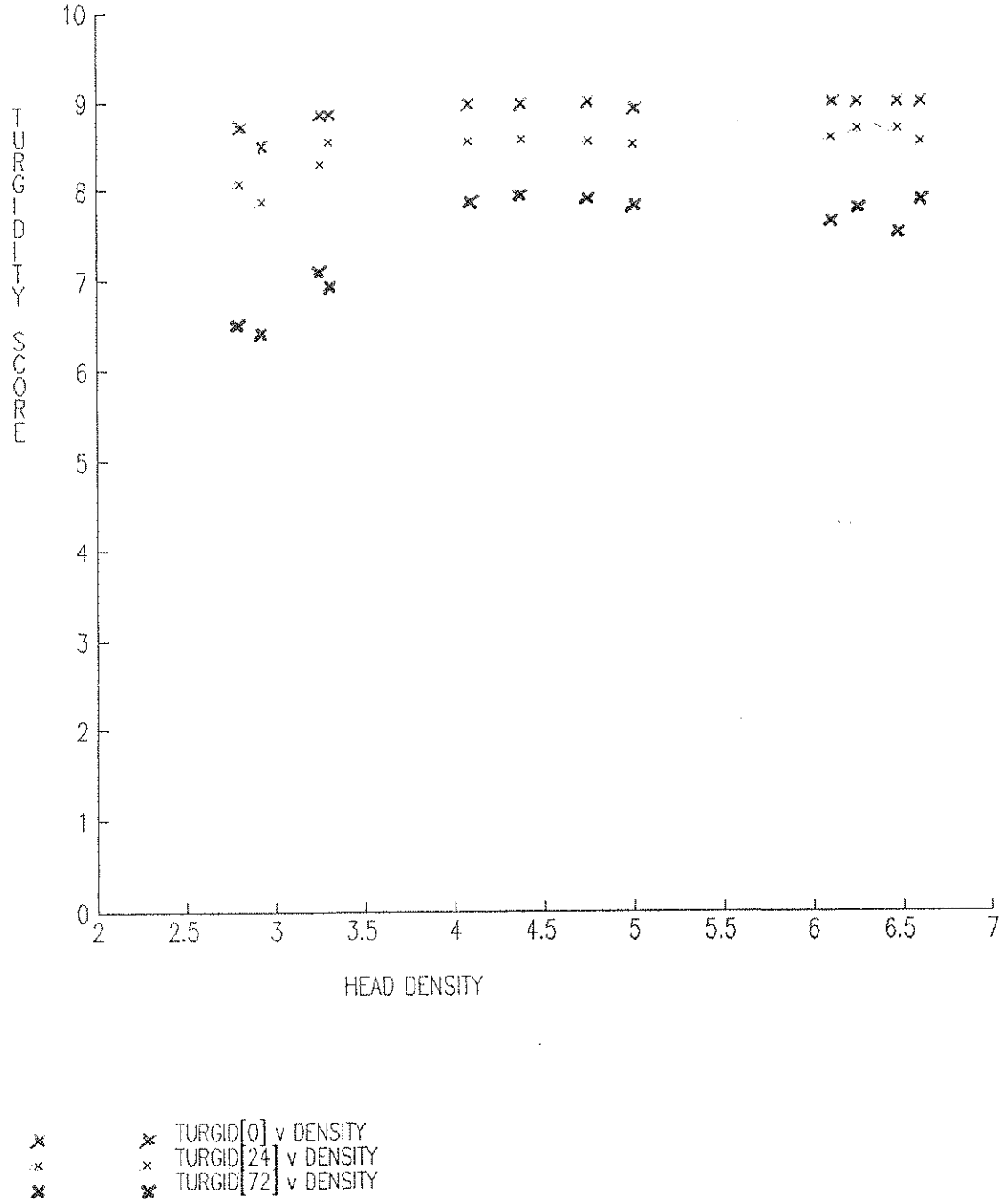
Graph 4 Regression analysis of disease scores throughout shelf life (where 9 = excellent)

Trial 3 (Saladin II)



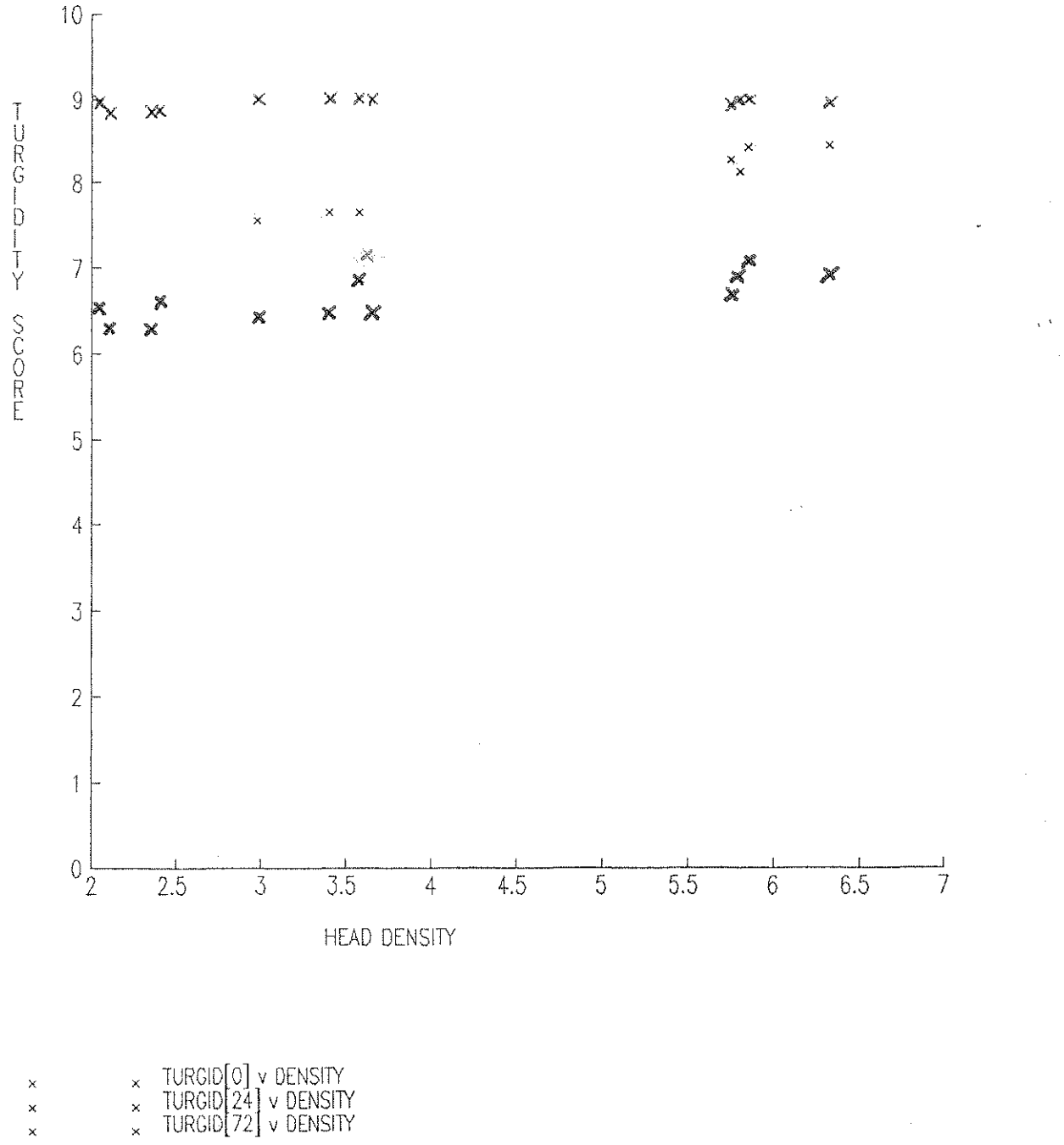
Graph 5 Regression analysis of turgidity scores throughout shelf life (where 9 = excellent)

Trial 1 (Kelvin)



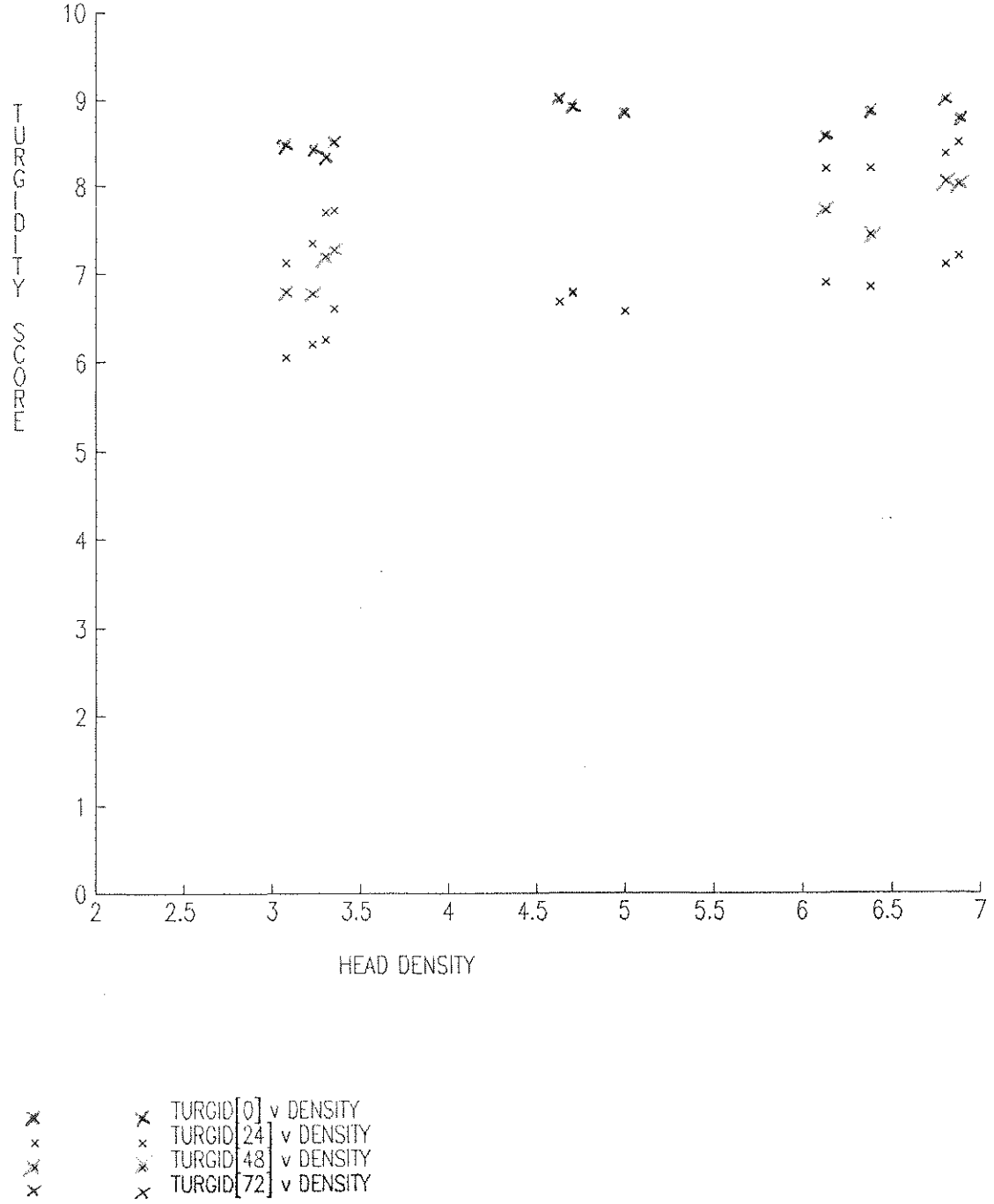
Graph 6 Regression analysis of turgidity scores throughout shelf life (where 9 = excellent)

Trial 2 (Saladin I)



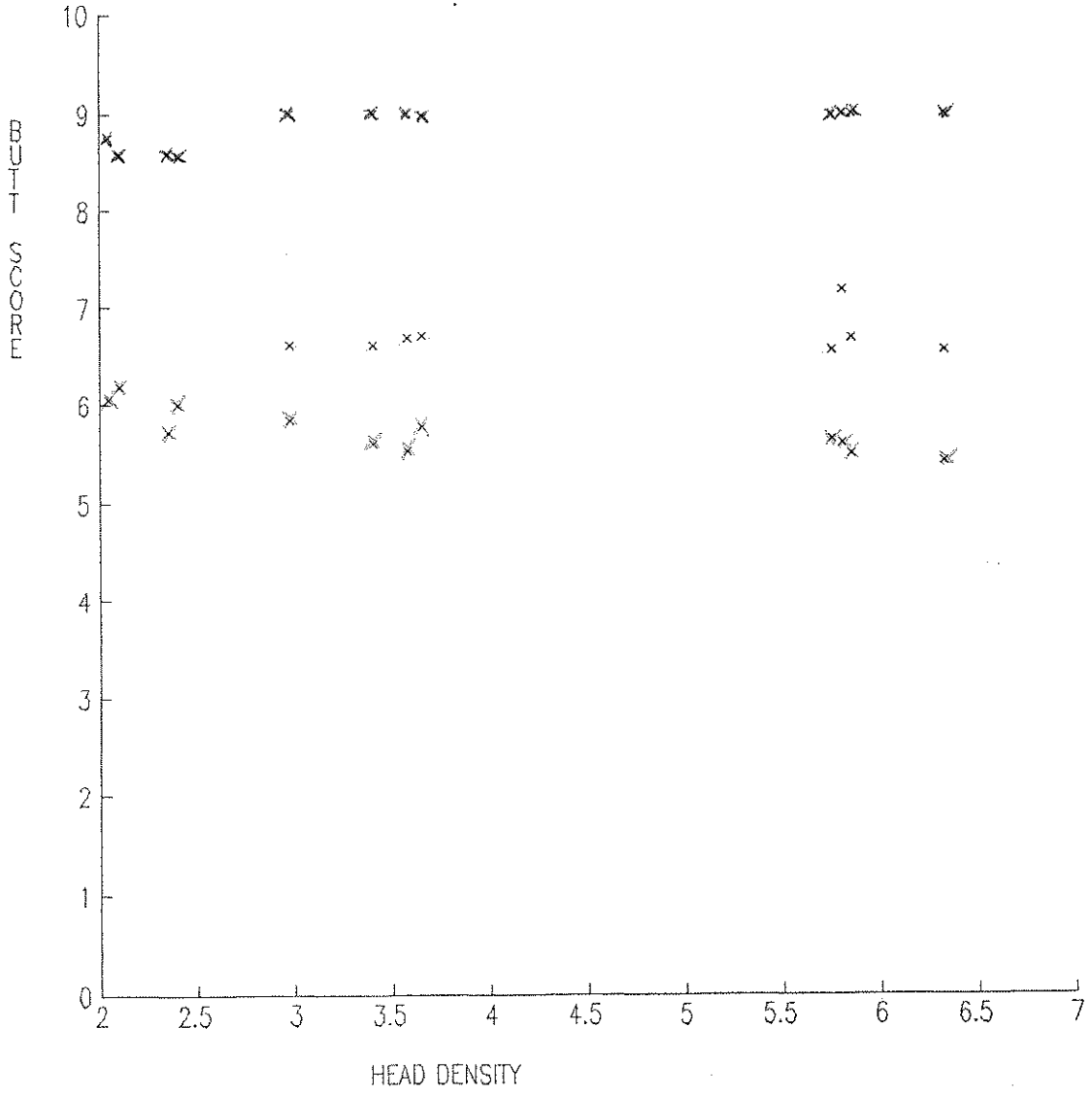
Graph 7 Regression analysis of turgidity scores throughout shelf life (where 9 = excellent)

Trial 3 (Saladin II)



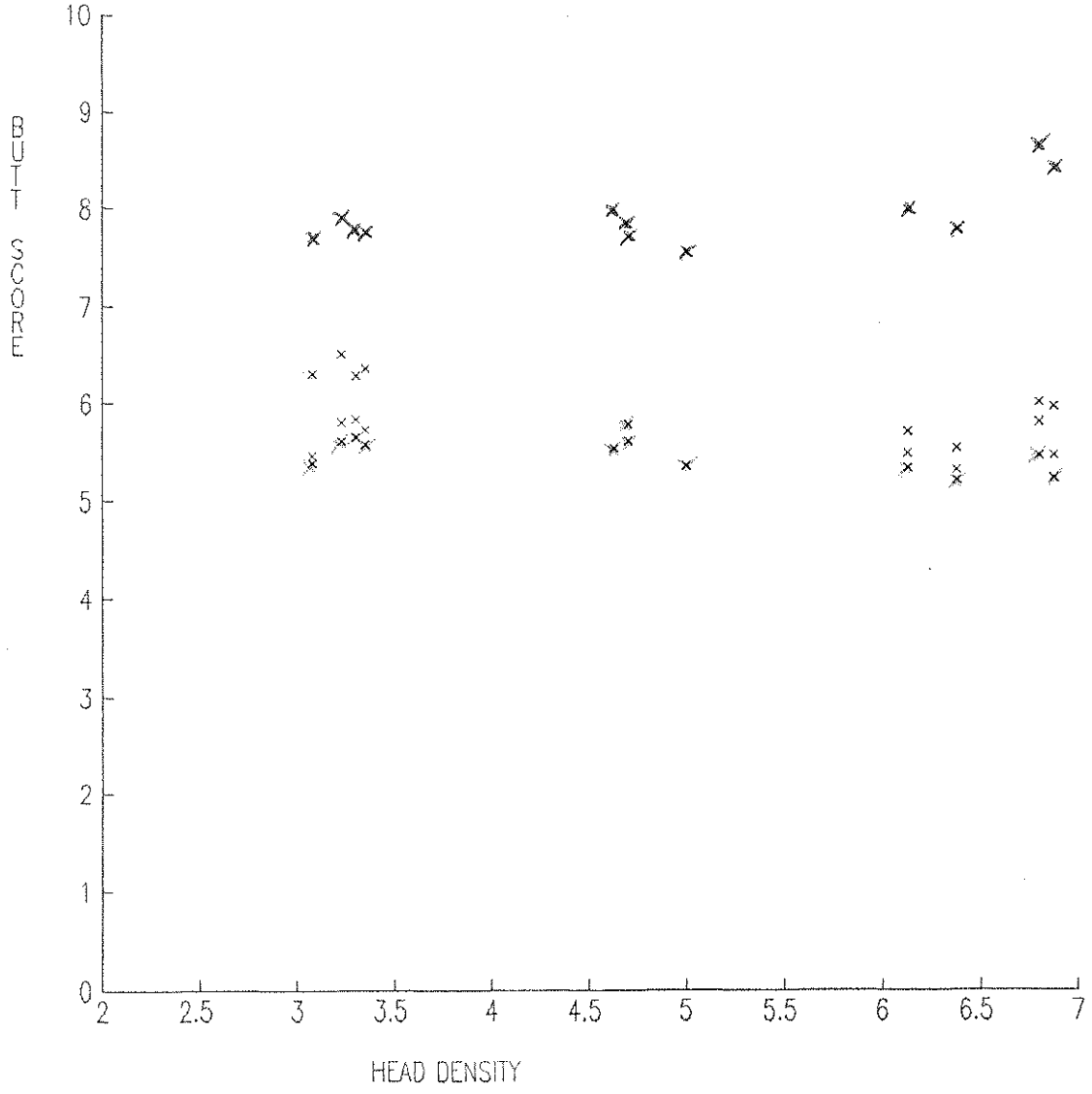
Graph 8 Regression analysis of butt scores throughout shelf life (where 9 = excellent)

Trial 2 (Saladin I)

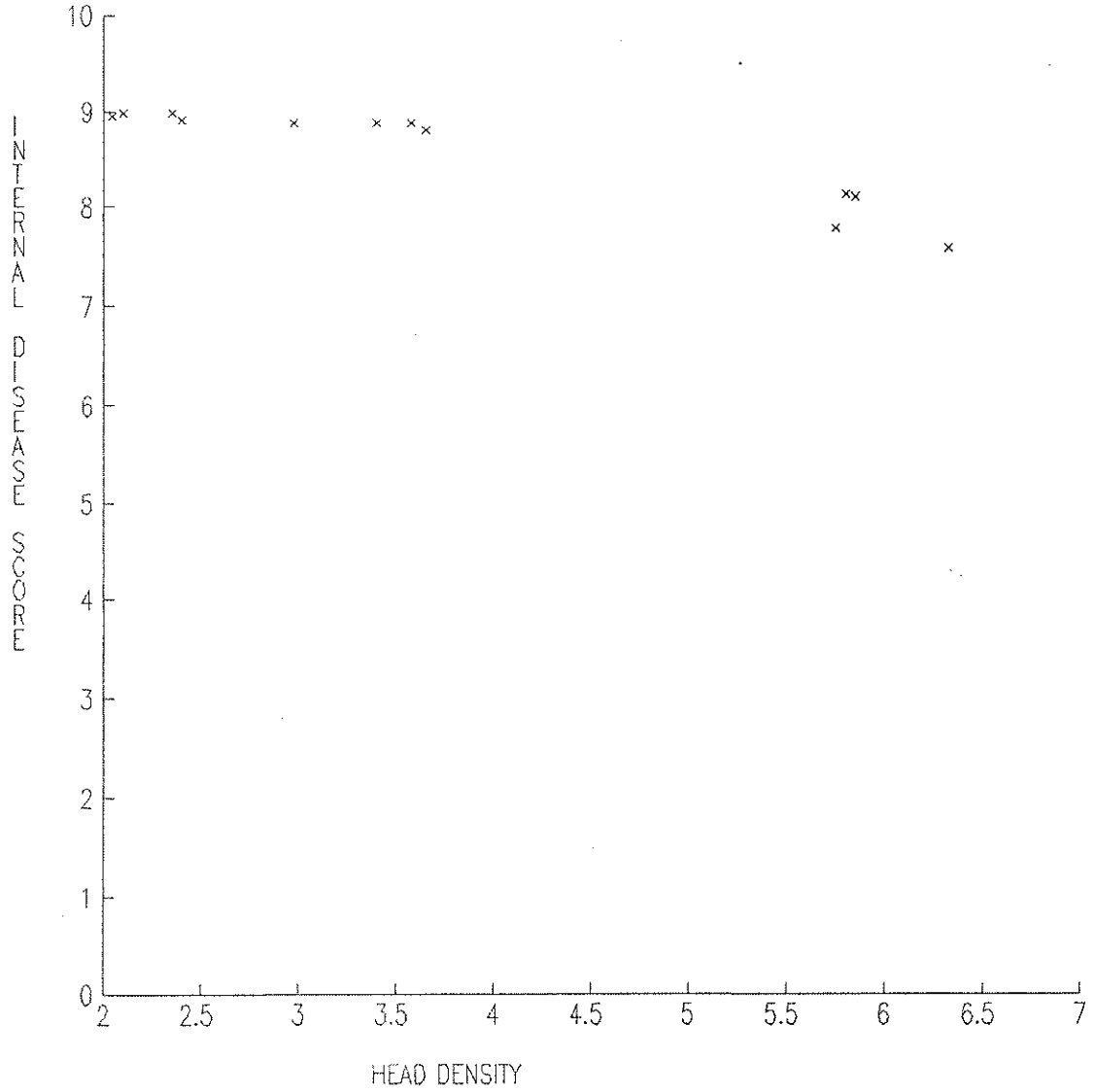


Graph 9 Regression analysis of butt scores throughout shelf life (where 9 = excellent)

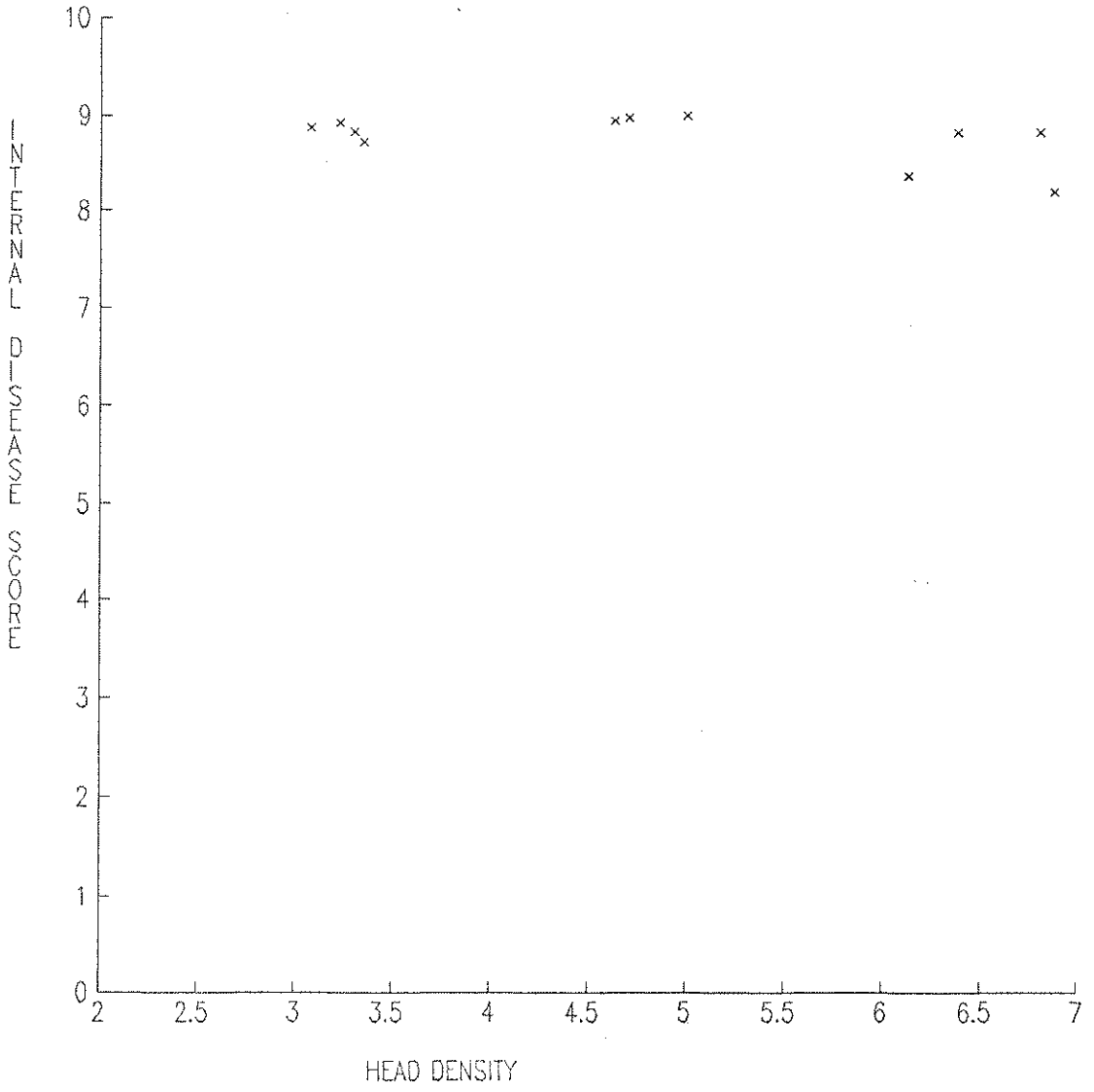
Trial 3 (Saladin II)



Graph 10 Regression analysis of internal disease scores (where 9 = excellent)
Trial 2 (Saladin I)



Graph 11 Regression analysis of internal disease scores (where 9 = excellent)
Trial 3 (Saladin II)



Density scores for iceberg lettuce