BBRO project 06/07: Post-harvest storage losses of different varieties in clamp and consequences of triazole usage on beet storage

PJ Jarvis
British Sugar plc

Final report
May 2008

BBRO project 06/07: Post-harvest storage losses of different varieties in clamp and consequences of triazole usage on beet storage:

Summary

In a two-year project conducted by British Sugar plc, clamps were constructed at two sites, using beet grown on a sandy loam and clay loam soils. Storage losses for beets of varieties Salvador (a high-root-weight, low-sugar-concentration variety), Ace (a low-root-weight, high-sugar-concentration variety), and Dominika (an intermediate variety) and beet of the variety Ace grown to produce low-sugar concentration beet were compared.

In the second year only, storage losses for beet receiving a late triazole fungicide application were compared with an untreated control.

The losses of sugar and changes in beet quality were measured using a paired netted sample technique. And beet was stored for 54 - 77 days towards the end of the 'campaign'.

Sugar weight losses mirrored sugar concentration changes in store. Differences between varieties were small but occasionally significant. However there was no obvious trend to sugar content type. The effect of agronomy (and the resulting sugar concentration of beet) did not appear to affect the sugar losses in storage. The use of a triazole fungicide did not affect storage losses.

Introduction

Sugar beet processing campaigns now run into late February, and much of the beet delivered during the latter stages will come from on-farm clamps. It is known that there will be significant losses of sugar from beet stored in such clamps between the lifting of the beet and its delivery to the factory. The BBRO funded project 02/26[1] looked at the standards for long-term, post-harvest storage of beet in clamps. There were significant decreases in sugar concentration and losses of sugar, between experiments. The smallest losses occurred with Cinderella and Roberta, intermediate losses with Dominika, Giovanna, and Latoya, and the largest losses with Gandalf and Stallion. However, it was not clear in these experiments whether the sugar losses during storage were inherent to the varieties or more directly related to the sugar content of their beet. Work in the USA has shown that varieties differ greatly in their rates of post-harvest respiration (Wyse 1978)[2] and, in recent short-

[1] BBRO Report 02/26 Long-term beet storage

[2] Wyse R E, J C Thuerer & DL Doney (1978) Genetic variability in post-harvest respiration rates of sugar beet. *Crop Science vol18 pp264-266*

term trials in Germany, Kenter (2005)[3] measured genotypic differences in sugar loss in clamped beet.

There is also concern that there may be larger losses in store, from beet which may have received a foliar application of a triazole fungicide which has been shown to preserve the leaf greenness and maintain active canopy growth. This may be particularly apparent when a second later fungicide application is made closer to the time of harvest and store.

Objectives

1) To compare the rates of sugar loss and changes in beet quality in a range of sugar-beet varieties stored using the best current practices.
2) To examine the rates of sugar loss and changes in beet quality when beet of a single variety but differing in sugar concentration are stored using the best current practices.
3) To quantify the losses in store of beet treated with late applications of triazole fungicides and compare these with the losses from beet that have a non-triazole applied

Materials and Methods

Clamps were constructed at two sites, one in the Newark factory area and one in the Bury St Edmunds factory area, using beet grown on a sandy loam and clay loam soil respectively (Table 1). Each clamp contained approximately 300 tonnes, and were constructed to the same basic pattern i.e. approximately 9m wide, 25m long, 2.5m high at the centre, contained within walls of big square straw bales (1.2m high) that were placed upon pallets positioned to allow free flow of air at the bottom of the wall. They were protected with Polyfelt sheeting as necessary, and stored as stipulated by British Sugar best-practice advice. The beet was stored for 54 - 77 days and delivered to the local factory towards the end of the 'campaign'.

In each of the two years of the project three varieties - Salvador (a high-root-weight, low-sugar-concentration variety), Ace (a low-root-weight, high-sugar-concentration variety), and Dominika (an intermediate variety) - were grown at the recommended plant population density and with the recommended rate of fertilizer N. Dominika is a variety extensively used in past storage trials, and thus serves as a useful reference. Beet from these plots provided a test of the effect of variety on sugar losses during storage. In addition, beet of the variety Ace was grown at a lower than recommended plant population density (65000 plants/ha) and with a larger than standard amount of fertilizer N (180 kg/ha). This was to produce low-sugar-concentration beet to study the effect, on sugar losses during storage, of a change in sugar concentration within a single variety.

[3] C Kenter (2005) Changes in sugar beet quality during storage as affected by agronomic measures. Communication to the *IIRB Beet Quality Group, October 2005.*

The experimental beet tested in these clamps was grown, in replicated plots, adjacent to the storage site.

The losses of sugar and changes in beet quality were measured using 25 paired netted-bag samples (i.e. 25 replicates) each containing approximately 15-20 kg of beet. One net of each pair, from the three varieties and from the N rate/plant population treatment was taken to Wissington tare house for immediate analysis as the clamps were built. The other nets were placed at predetermined positions within the clamp. These positions represented the vertical profile of the clamp (Figure 1). Hence, in each clamp there were a total of 100 nets, distributed as one net per treatment in each of 25 locations within the clamp. The order of the treatments was randomized within each position or replicate in the clamp.

The bagged samples were recovered, weighed on site, and then delivered to the Wissington tare-house for analysis of dirty weight, clean weight, % sugar concentration and root impurities. Most sugar in store is lost as a result of sugar concentration loss rather than beet weight loss, so the percentage of sugar lost per day and the percentage of sugar concentration loss per day were calculated at the end of the storage period.

In the second year only, of this project, at each of the two sites above, one strip of uniform beet of a single variety was grown adjacent to the storage clamp. This strip received a late triazole fungicide application. An adjacent comparable strip will be was kept free of triazole fungicides. Powdery Mildew was controlled by two applications of a quinoxyfen (Fortress) spray. Beets were harvested carefully, to produce a sample to good practice (which would be expected to reduce losses in store). The losses of sugar and changes in beet quality were measured using 50 paired samples (i.e. 50 replicates) each containing approximately 15-20 kg of beet. Again one net of each pair, from the triazole treated and the triazole free treatments was taken to Wissington tare house for immediate analysis as the clamps were built. The other nets were placed at predetermined positions within the clamp. The same clamp as used for the variety assessment was used as the carrier for this evaluation at each of the two sites in the second year of the project. These positions represented the vertical profile of the clamp (Figure 1). Hence, in each clamp there were a total of 100 nets, distributed as one net per treatment in each of 25 locations within the clamp. The order of the treatments was randomized within each position or replicate in the clamp.

The bagged samples were recovered, weighed on site, and then delivered to the Wissington tare-house for analysis of dirty weight, clean weight, % sugar concentration and root impurities. Most sugar in store is lost as a result of sugar concentration loss rather than beet weight loss, however, both the percentage of sugar weight lost per day and the percentage of sugar concentration loss per day were calculated at the end of the storage period.

Site Name	Year	County	Grid Ref.	Soil texture	Start date	Storage period (days)	Clamp base
Hibaldstow	2006	Lincs	498402	sandy loam	4 Dec	57	concrete
Old Buckenham	2006	Norfolk	607292	clay loam	6 Dec	54	concrete
Hibaldstow	2007	Lincs	498402	sandy loam	26 Nov	77	concrete
Old Buckenham	2007	Norfolk	607292	clay loam	4 Dec	55	concrete

Table 1. *Site and clamp construction details*

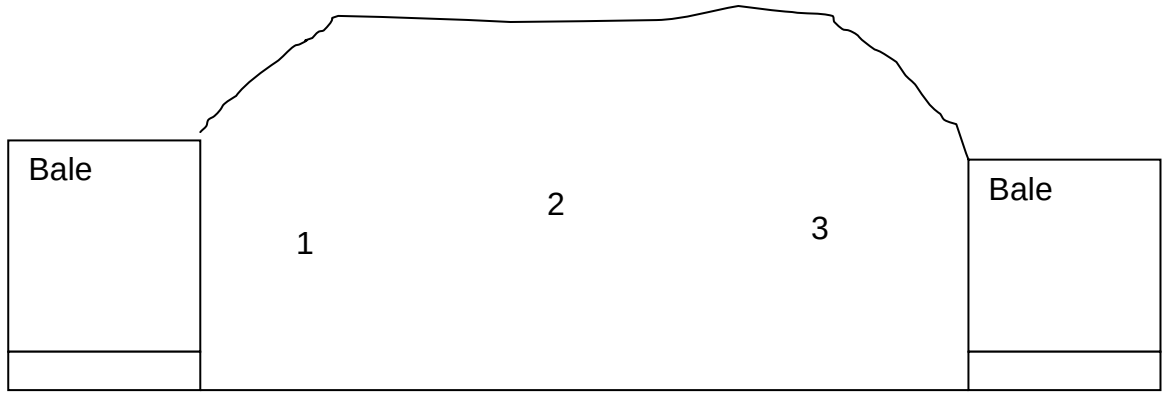

Fig. 1. *Position of samples on the clamp cross section*

A series of thermistor probes were buried with the samples in the central 'hotspot' position along the length of the clamp. These were purely used to monitor the status of the clamps and ensure that no overheating of the beet was occurring. These measurements were not used in analysis.

Whenever sharp frosts were forecast the top and end faces of the clamps were covered with a Polyfelt sheet. On a day-to-day basis these covers were removed when danger of frost had passed.

After 54-77 days the clamps were dismantled and the sample nets were carefully retrieved. The temperature data were down loaded for archive and analysis as necessary.

The yield and beet quality data were analysed for each clamp using GENSTAT.

Results and Discussion

Post-harvest storage losses of different varieties and beet of different sugar concentration in clamp

Visual assessments

Beet for the Hibaldstow clamp were from a sandy loam part of the field. Soil conditions were wet. The beet were in good condition and there were no rotted roots. At Old Buckenham the soil type was heavier and beet had been bruised by the harvester, where the cleaning had been vigorous.
When the Hibaldstow clamp was opened, beet in the centre of the clamp had sprouted, were dry but were otherwise in good condition. There was a similar situation at Old Buckenham.

Temperature

No excessive heating of the storage clamps was observed and as treatments were distributed evenly within the clamps, clamp temperature is not considered.

Sugar concentration losses in store

The initial sugar concentrations of the material put into store were a little variable and not always expected (see table 2).

		Ace	Dominika	Salvador	Ace low%s	F pr.	s.e.d.
2007 HI in store 77 days	initial %s	19.548	19.134	18.999	19.556	0.002	0.1213
	final %s	17.462	17.222	16.527	17.354	0.002	0.1745
2007 OB in store 55 days	initial %s	19.361	18.763	18.537	18.912	0.013	0.1952
	final %s	17.851	17.612	16.940	17.803	0.042	0.2922
2006 HI in store 57 days	initial %s	17.980	18.270	18.200	17.360	<.001	0.1342
	final %s	16.705	17.110	16.980	16.090	<.001	0.1535
2006 OB in store 54 days	initial %s	18.083	18.074	17.912	17.912	0.319	0.1250
	final %s	16.516	16.321	16.251	16.590	0.078	0.1472

Table 2. *Initial and final sugar concentration of stored beet, 2006-07*

At Hibaldstow in 2007 we had the expected differences between varieties, but no reduction in the sugar concentration of Ace by agronomic means was achieved.
At Old Buckenham in 2007 both the expected differences between varieties and the reduction in the sugar concentration of Ace by agronomic means was achieved.
At Hibaldstow in 2006 there were no significant differences between any of the varieties, but a reduction in the sugar concentration of Ace by agronomic means was achieved.
At Old Buckenham in 2006 there were no significant differences between any of the treatments.

It appears (from previous storage work) that most sugar loss in store is lost as a result of sugar respiration rather than as a loss of beet weight. The sugar concentration reduction for each of the three varieties and for the variety Ace manipulated to give a low sugar concentration, as a percentage sugar concentration reduction per day are given in table 3

		Ace	Dominika	Salvador	Ace low%s	F pr.	s.e.d.
2007	HI	0.1383	0.1296	0.1690	0.1461	0.012	0.00932
2007	OB	0.1412	0.1109	0.1565	0.1061	0.048	0.01723
2006	HI	0.1204	0.1108	0.1172	0.1274	0.661	0.01333
2006	OB	0.1515	0.1690	0.1614	0.1283	0.073	0.01615
	mean	0.1379	0.1301	0.1510	0.1270		

Table 3. *Percentage change in sugar concentration per day during storage in four clamps, 2006-07*

In 2006 there were no significant differences in either clamp between any of the varieties from the effect of agronomy on sugar content, or on the effect on sugar content change through storage.
However in 2007 genotype differences were evident. The low sugar concentration variety Salvador produced the greatest losses. At Hibaldstow the other two varieties, Ace and Dominika, produced similar lower losses; although the variety Ace grown to low sugar concentration gave higher (but still intermediate) losses. At Old Buckenham the variety Dominika produced smallest losses; and Ace produced intermediate losses when grown to standard practice but equivalent low losses to Dominika when grown to produce low sugar content.

Sugar weight losses in store

The reduction in sugar weight of the samples was estimated as a percentage loss per day for each of the three varieties and for the variety Ace manipulated to give a low sugar concentration. Results are shown in table 4

		Ace	Dominika	Salvador	Ace low%s	F pr.	s.e.d.
2007	HI	0.0869	0.0764	0.1263	0.0958	0.002	0.00899
2007	OB	0.1198	0.0848	0.1357	0.0870	0.067	0.01918
2006	HI	0.0990	0.0900	0.0980	0.1120	0.313	0.01202
2006	OB	0.1512	0.1665	0.1541	0.1279	0.250	0.01933
	mean	0.1142	0.1044	0.1286	0.1058		

Table 4. *Percentage loss of sugar weight per day in four clamps 2006-07*

In 2006 results from both experiments produced non-significant differences and any trends were conflicting. However in 2007 genotype differences were evident. The low sugar concentration variety Salvador produced the greatest losses. At Hibaldstow the other two varieties, Ace and Dominika, produced similar lower losses; this was true for the variety Ace both when grown to standard practice and when grown to produce low sugar content roots. At Old Buckenham, Ace produce intermediate losses when grown to standard practice but equivalent low losses to Dominika when grown to produce low sugar content.

Post-harvest storage losses in clamp of beet treated with triazole fungicides

Sugar concentration losses in store

The initial sugar concentrations of the material put into store indicated that for both experiments in 2007 the triazole treated beet had a greater sugar concentration at the start of storage (this reflects results from fungicide assessment trials which show triazole fungicides to confer a sugar yield benefit even in the absence of disease). This difference continued to be present at the end of the storage period although to a less significant level at Old Buckenham. See table 5.

		Cabaret	Fortress	F pr.	s.e.d.
2007 HI	initial %s	18.882	18.648	<.001	0.0288
in store 77 days	final %s	17.005	16.723	<.001	0.0681
2007 OB	initial %s	18.887	18.662	<.001	0.0329
in store 55 days	final %s	18.009	17.892	0.076	0.0647

Table 5. *Initial and final sugar concentration of stored beet, 2007*

Table 6 gives the rate at which sugar concentration was reduced for the two treatments. As stated above, it appears that most sugar loss in store is lost as a result of sugar respiration rather than as a loss of beet weight.

		Cabaret	Fortress	F pr.	s.e.d.
2007	HI	0.1289	0.134	0.3	0.0048
2007	OB	0.0813	0.0722	0.183	0.00673
	mean	0.1051	0.1031		

Table 6. *Percentage change in sugar concentration per day during storage in 2007*

There was no difference in the rate that the treatments reduced sugar concentration during storage.

Sugar weight losses in store

The reduction in sugar weight of the samples was estimated as a percentage loss per day for each of the two fungicide treatments. Results are shown in table 7

		Cabaret	Fortress	F pr.	s.e.d.
2007	HI	0.0904	0.098	0.183	0.00558
2007	OB	0.0801	0.0831	0.647	0.0067
	mean	0.08525	0.09055		

Table 7. *Percentage loss of sugar weight per day in 2007*

There was no difference in the rate that the treatments lost sugar yield during storage

Discussion and Conclusions

Generally the variety Dominika produced lower losses in clamp, particularly where it did start the storage period with a higher sugar concentration. However there is no obvious trend of higher sugar content varieties producing smaller losses in storage. So it appears that varieties may differ in their storability, but that differences are very small and in this study were not significant enough to discriminate between them.

The effect of agronomy and the resulting sugar concentration of beet, does not appear to affect the sugar losses in storage

The use of a triazole fungicide used to control leaf diseases (which has been shown to preserve the leaf greenness and maintain active canopy growth), has not been seen to result in greater storage losses than the use of a non-triazole (quinoxyfen) fungicide to control disease, even when a second later fungicide application is made closer to the time of harvest and store.