



Full Length Article

Post-Harvest Studies in Sugarbeet (*Beta vulgaris*)

MUHAMMAD ALEEM SARWAR¹, FAQIR HUSSAIN, ABDUL GHAFAR, MUHAMMAD ASHFAQ NADEEM, MUHAMMAD MUSHTAQ AHMAD[†], MUHAMMAD BILAL[‡], ARSHAD ALI CHATTHA AND MUHAMMAD SARWAR[¶]

Sugarcane Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan

[†]*Food Technology Section, Ayub Agricultural Research Institute, Faisalabad, Pakistan*

[‡]*Department of Agronomy, University of Agricultural, Faisalabad, Pakistan.*

[¶]*Department of Statistics, Ayub Agricultural Research Institute, Faisalabad, Pakistan*

¹Corresponding author's e-mail: aleemsarwar7500@yahoo.com

ABSTRACT

A three years field study was conducted to investigate post harvest behavior of sugarbeet with respect to weight, pol and sugar recovery. The treatments comprised four beet varieties viz; Pamela, Kawe Terma, KWS-1451 and Aura, six storage days (at one day interval) after harvest and two storage conditions (under sun under shade). The results envisaged that Pamela lost maximum weight, 17.98% and 18.78% under shade and sun stored conditions, respectively. Similarly, maximum pol (16.06 & 16.43%) as well as maximum sugar recovery (13.56 & 13.92%) was recorded in Aura stored under shade and sun conditions. A steady increase in pol and sugar recovery but a decrease in weight of all varieties was noted stored under sun and shade.

Key Words: Sugarbeet; Weight losses; Pol; Sugar recovery

INTRODUCTION

Sugarbeet (*Beta vulgaris* L.) is an import source of sugar like sugarcane (*Saccharum officinarum*). It is a temperate crop but also cultivated under arid and semi arid climatic conditions. It was cultivated on an area of 3.1 thousand hectares giving an annual production of 93.4 thousand tones and average yield of 30.1tonnes ha⁻¹ during 2005-2006 (Anonymous, 2006). Sugarbeet is facing some problems with respect to climate and variety related to after harvest like weight losses, rotting and staleness, leading to declined sugar recovery. Houghton *et al.* (1998) compared the efficiency of three covering materials viz; straw, woven poly propylene and polyfelt to protect harvested sugarbeet piles against frost during storage. Polyfelt was found to be the most effective, durable and easily handled, while straw became wet and allowed frost to penetrate into clamps. Wyse and Dexter (1971) examined that glucose and fructose accumulated in the sugar beet stored above 5°C, while raffinose, glucose and fructose formed at storage temperature below 5°C. They also observed a decrease in after harvest sucrose concentration due to its inversion to reducing sugars and oligosaccharides. Similarly the wounds in the sugarbeet tap root also accelerate sucrose inversion due to invertase activity during post harvest period (Rosenkraz *et al.*, 2001).

Singh *et al.* (1993) studied losses percentage with respect to weight and sugar in the sugar beet crop harvested two times during three months i.e., March, April and May and recorded 24-25% sugar losses in the crop harvested in late April/May as compare to 6-12% losses in March/early

April harvested crop. The same trend was found in weight losses when maximum (25%) weight losses were noticed during harvesting in May. They proposed that advancing the post harvest period was an effective tool for minimizing post harvest losses in sugarbeet in North West Indian regions. Augustinussen *et al.* (1995) noted the sugar losses in un-damaged, slightly damaged, moderately damaged, severely damaged and mechanically harvested sugar beet.

Variable losses were reported as 0.73% losses of the total sugar yield in undamaged to slightly damage after one week of storage and 2.25% after six weeks. In the same way, 0.08% and 0.26% through bruising in moderately to severely damaged sugar beet, 0.04% and 0.18% through tap root breakage and 0.05% and 0.19% through over topping. Similarly, some organic substances such as cytokinins including benzyl adenine and its derivatives and hydroxyl benzyl adenosine that affect yield and quality of sugar beet by decreasing post harvest root metabolism and sugar losses during storage (Zahradineck *et al.*, 1996). Zeng *et al.* (1991) compared the activities of four invertases like soluble acid invertase binding acid invertase, soluble neutral invertase and binding neutral invertase in sugar beet roots stored at -20, 0, 5 and 10°C for five days. A decreased activity of all three invertases except soluble acid invertase was noticed. Similarly at 10°C storage temperature root membrane permeability, sap acidity and reducing sugars were increased. Malik *et al.* (2003) recorded variable post harvest behavior of three sugar beet varieties with respect to weight losses and increase in pol percentage during six days of storage. They also highlighted a need of proper insulation material to reduce losses.

The post harvest behavior of sugar beet also indicates an increase in sugar contents for a few days due to decrease in moisture contents during storage (Chen & Chou, 1993). Keeping in view the above background, a field experiment was conducted to study post harvest behavior of four sugar beet varieties at Faisalabad.

MATERIALS AND METHODS

A field experiment was planned at Sugarcane Research Institute, Ayub Agricultural Research Institute, Faisalabad during three consecutive crop seasons from 2003 to 2006 in split plot arrangement keeping varieties in sub plots. Sowing was done during November and harvested in May every year. All recommended agronomic and cultural operations including weeding, fertilization, irrigation and plant protection measures were followed during the entire course of study. At harvest, thirty six healthy, mature, un-rotten beet samples of each variety were collected, properly washed and divided into twelve lots of twelve bulbs each, sub divided into two sub lots for storing under two different conditions i.e., shade and sun, covering them with 45 cm thick cane bagasse. Data were recorded for sample weight before storage and regularly on daily basis before crushing in order to determine evaporation losses. Polarity was determined by Horn's dry-lead method (Spencer & Meade, 1963) to evaluate pol and sugar recovery percentages. The data were subjected to statistical analysis and varietal means were compared with LSD test of significance at 5% probability levels as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Percent weight losses in sugar beet. Beet weight is a

matter of concern for the growers as they are paid on weight basis. The data indicated statistically significant variation among in varieties with respect to weight losses (Table I & II). A maximum weight loss (17.98%) was recorded in Pamela during storage in shade that was followed by Kawe Terma (17.10%), KWS-1451 (16.56%) and Aura (16.44%) in descending order. Similarly Aura showed minimum weight losses (15.86%) when the samples were placed for storage under sun for six days. Aura was followed by KWS-1451 (17.74%), Kawe Terma (18.73%) and Pamela (18.78%) in ascending order, while varieties Pamela and Kawe Terma were similar. Beet roots weight decreased regularly during storage whether under shade or sun but the higher weight losses under sun may be due to higher temperature because of direct sun rays. This explanation is in harmony with those elucidated by Singh *et al.* (1993) and Malik *et al.* (2003) who also indicated a similar kind of trend in their studies.

Pol% in sugar beet. Pol percentage is very important character for millers. Significant differences for pol among four beet varieties were noted (Table III & IV). Maximum pol (16.06%) was noticed in Aura and minimum (14.89%) in Pamela when stored samples were kept in shade. Similarly, maximum (16.43%) and minimum (15.69%) pol was observed in Aura and Pamela respectively when these varieties were stored under sun although varieties Pamela, Kawe Terma and KWS-1451 were statistically at par (Table IV). This indicated an inverse relation between weight losses and pol percent increase in all varieties. The increase in sucrose contents with progressively decreasing weight might be due to water evaporation and condensation of sap in beet samples. These observations are in line with what is claimed by Malik *et al.* (2003) and Chen and Chou (1993).

Table I. Three years pooled analysis of percent weight losses in shade

Sr. #	Varieties	% Weight losses during storage in shade 1-6 days						Average
		1	2	3	4	5	6	
1.	Pamela	0	11.60 ij	15.02 g	19.38 de	21.27 bc	23.64 a	17.98 a
2.	Kawe Terma	0	9.39 j	12.68 h	19.22 e	20.68 bcd	23.55 a	17.10 b
3.	KWS-1451	0	10.38 ij	13.12 h	15.94 fg	19.17 e	24.49 a	16.56 bc
4.	Aura	0	11.08 i	12.98 h	16.61 f	19.93 cde	21.58 b	16.44 c
	Average	0	10.29 e	13.45 d	17.79 c	20.26 b	23.32 a	

LSD at 5% for varieties, 0.6363; days, 0.7114, years, 0.3286 and interaction, 1.423

Table II. Three years pooled analysis of percentage weight losses in sun

Sr.#	Varieties	Percent weight losses during storage in sun 1-6 days						Average
		1	2	3	4	5	6	
1.	Pamela	0	11.02 lm	15.56hi	19.66 ef	22.58 c	25.13 b	18.78 a
2.	Kawe Terma	0	9.19 h	14.78ij	20.55 de	22.72 c	26.40 ab	18.73 a
3.	KWS-1451	0	8.79 h	12.70hl	17.18 gh	23.06 c	26.95 a	17.74 b
4.	Aura	0	9.78 mn	13.35jh	15.83 hi	18.30 fg	22.02 cd	15.86 c
	Average	0	9.70 e	14.10d	18.30 c	21.66 b	25.11 a	

LSD at 5% for varieties, 0.7651; days, 0.8554, years, 1.069 and interaction, 1.711

Table III. Three years pooled analysis of Pol (%) in shade

Sr. #	Varieties	Pol % during storage in shade 1-6 days						Average
		1	2	3	4	5	6	
1.	Pamela	12.56	13.66	14.40	15.48	16.01	17.19	14.89 c
2.	Kawe Terma	12.77	14.90	15.21	15.89	17.23	17.82	15.64 b
3.	KWS-1451	13.09	14.47	15.20	16.09	17.67	18.30	15.81 ab
4.	Aura	13.43	14.96	15.44	16.81	17.45	18.31	16.06 a
	Average	12.96 f	14.50 e	15.06 d	16.07 c	17.09 b	17.91 a	

LSD at 5% for varieties, 0.4213; days, 0.5160 and years, 0.1745

Table IV. Three years pooled analysis of pol in sun

Sr. #	Varieties	Pol (%) during storage in sun 1-6 days						Average
		1	2	3	4	5	6	
1.	Pamela	13.33	14.30	15.02	15.97	17.14	18.35	15.69 b
2.	Kawe Terma	13.30	14.14	15.16	15.47	17.56	18.64	15.71 b
3.	KWS-1451	12.68	13.32	15.16	16.48	17.50	18.70	15.64 b
4.	Aura	13.29	15.00	16.20	17.00	18.14	18.92	16.43 a
	Average	13.15 f	14.19 e	15.39 d	16.23 c	17.59 b	18.65 a	

LSD at 5% for varieties, 0.4570; days, 0.5597 and years, 0.6064

Table V. Three years pooled analysis of sugar recovery in shade

Sr.#	Varieties	Sugar recovery % during storage in shade 1-6 days						Average
		1	2	3	4	5	6	
1.	Pamela	10.06	11.16	11.91	12.98	13.51	14.69	12.39 c
2.	Kawe Terma	10.27	12.40	12.71	13.39	14.73	15.32	13.14 b
3.	KWS-1451	10.59	11.97	12.70	13.59	15.17	15.80	13.31 ab
4.	Aura	10.93	12.46	12.94	14.31	14.95	15.81	13.56 a
	Average	10.46 f	12.00 e	12.56 d	13.57 c	14.59 b	15.40 a	

LSD at 5 % for varieties, 0.4177; for days, 0.5116 and for years, 0.2079

Table VI. Three years pooled analysis of sugar recovery in sun

Sr. #	Varieties	Sugar recovery (%) during storage in shade 1-6 days						Average
		1	2	3	4	5	6	
1.	Pamela	10.83	11.80	12.52	13.47	14.64	15.85	13.19 b
2.	Kawe Terma	10.80	11.64	12.66	12.97	15.06	16.14	13.12 b
3.	KWS-1451	10.18	10.82	12.66	13.98	15.00	16.20	13.14 b
4.	Aura	10.79	12.50	13.70	14.50	15.64	16.42	13.92 a
	Average	10.65 f	11.69 e	12.89 d	13.73 c	15.09 b	16.16 a	

LSD at 5 % for varieties, 0.4570; for days, 0.5597 and for years, 0.6063

Sugar recovery % in sugar beet. There was a direct relationship between pol and sugar recovery in sugarbeet. The data showed that minimum sugar recovery (12.39%) was observed in Pamela and it was followed by Kawe Terma, KWS-1451 and Aura by producing 13.14%, 13.31% and 13.56% sugar recovery in ascending order (Table V). However, Aura and KWS-1451 as well as KWS-1451 and Kawe Terma were statistically at par. Similarly, maximum sugar recovery (13.92%) in Aura and minimum (13.14%) in KWS-1451 was noted (Table VI). This envisaged the fact that increase in sugar recovery during initial days of storage might be due to moisture loss from beets, increase in pol percentage due to sap condensation, analysis of un-damaged and unrotten samples as reported by Malik *et al.* (2003).

CONCLUSION

The study emphasizes a dire need to use proper covering material after harvest. Variety Aura proved to be best for farmers as it was less prone to evaporation losses, because they are paid on weight bases for this crop. Aura proved profitable for millers because of maximum sugar recovery. Furthermore, during hot month of May, stalling losses do not occur due to inversion for a few days.

REFERENCES

Anonymous, 2006. *Agricultural Statistics of Pakistan, 2005-06*, p: 40. Government of Pakistan, Ministry of Food, Agriculture and Livestock (Economics wing), Islamabad

Augustinussen, E., E. Smed and J.K. Steensen, 1995. *Sugar Loss in Damaged Sugar Beet*, p: 39. Losses in field, during storage and through washing. *SP Rapport-Statens Planteavlsvforsog*. No. 7

Chen, J.C.P. and C.C. Chou, 1993. *Cane Sugar Hand Book*, 12th edition, pp: 13-6. John Wiley and Sons. Inc. New York

Houghton, B., I. Hopkinson and A. Spetch, 1998. Crop protection after harvest. The next step. *British Sugar Beet Rev.*, 66: 27-30

Malik, I.A., F. Hussain, M. Anwar and A.A. Chattha, 2003. Some studies on post harvest behaviour of sugar beet varieties. *Pakistan Sugar J.*, 18: 17-9

Rosenkraz, H., R. Vogel, S. Greiner and T. Rausch, 2001. In wounded sugar beet (*Beeta vulgaris* L.) tap root, haxose accumulation correlates with the induction of a vacuolar invertase isoform. *J. Exp. Bot.*, 52: 2381-5

Singh, N., S.S. Toor and R.S. Narang, 1993. Post-harvest studies for efficient produce management in sugar beet. *Indian Sugar.*, 43: 505-10

Spencer, E.F. and G.P. Meade, 1963. *Cane Sugar Hand Book*, 9th edition. John Wiley and Sons, New York USA

Steel, R.G.D. and J.H. Torrie, 1980. *Principles and Procedures of Statistics: A Biomaterial Approach*. Mc Graw Hill Inc; New York, USA

Wyse, R.E. and S.T. Dexter, 1971. Source of recoverable sugar losses in several sugar beet varieties during storage. *J. American Soc. Sugar Beet Technol.*, 16: 390-8

Zahradineck, J., Z. Folbergerova, D. Fronck, J. Koubova, J. Kreckova, J. Catsky, M. Kaminek, J. Pospisilova, A. Kotyk, J. Pulkrabek, J. Seroller and V. Svachula, 1996. Effect of cytokinin treatment on the metabolism and technical quality of sugar beet. [Pat 2]. *Listy-Cukrovarnick-a-Reparske*, 112: 307-11

Zeng, X.B., X.Z. Cao and J.S. Liang, 1991. Relationship between invertase activities and quality of sugar beet roots during storage. *Acta Phytophysiol. Sin.*, 17: 239-44

(Received 24 September 2007; Accepted 21 January 2008)