R6508 C

Influence of post-harvest handling on the quality and shelf life of sweet potato (*Ipomoea batatas* (L) Lam)

G.T. Ndunguru[1], K.I. Tomlins[2*], E. Rwiza[3], A. Westby[2]

[1]*Tanzania Food and Nutrition Centre, 22 Ocean Road, P.O. Box 977, Dar es Salaam, Tanzania*

[2]*Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime, Kent, ME4 4TB, United Kingdom.*

[3]*ARTI-Ukiriguru, P.O. Box 1433, Mwanza, Tanzania*

Corresponding author. Tel.: +44 1634 883460; fax.: +44 1634 883714; e-mail address: K.I.Tomlins@gre.ac.uk *(K. I. Tomlins)*

[*]*Author for correspondence*

Abstract

Sweet potato is an important food crop in Africa. In Tanzania, sweet potatoes are traditionally handled and transported in polypropylene sacks that weigh 100 kg or greater, but losses in market value of 13% can occur. The effect of different factors during loading and unloading of sacks (weight, height and number of impacts) on the quality and shelf life of sweet potato (SPN/0 cultivar) was investigated. Considerable damage, resulting in broken roots, occurred when a sack was dropped from a height of 0.25 m or greater whereas skinning injury steadily increased with greater impact heights. Damage from broken roots and skinning injury increased the more times a sack was dropped. Quality was not influenced by the weight of the sack (50 or 100 kg). Skinning injury and to a lesser extent, broken roots, led to the greatest losses in shelf life (indicated by weight loss) during storage. The use of alternative methods of packaging to reduce handling and pre-harvest treatments (such as pruning prior to harvest) may lead to improved quality but need to be investigated.

Keywords: Sweet potato, *Ipomoea batatas*, storage, shelf life, postharvest handling, breaks, skinning injury, cuts, weight loss, Africa.

---

1. Introduction

In East Africa, sweet potato (*Ipomoea batatas* (L) Lam) remains an important crop. Production figures for 1998 indicate that it ranks third in importance in relation to 20 other major crops in Uganda and Kenya and seventh in Tanzania (Anon 2000). Handling and transport of sweet potato can lead to reduced market value, for example, in Tanzania losses were (13%) where up to 20% and 86% of roots were severely broken and skinned respectively (Tomlins *et al*. 2000). The most severe handling occurred during unloading and loading from road vehicles and ships, where porters dropped the sacks from shoulder height.

Injury can reduce the shelf life of sweet potato. Mechanical injuries sustained by retailing in bulk in New York supermarkets resulted in shelf life losses of approximately 5% through *Rhizopus* soft rot decay and moisture loss (Woolfe 1992). Skinning injury has been shown to be a major factor that contributes to weight loss during storage, make them more susceptible to rots and less appealing to consumers (Kushman 1975;

Stikeleather and Harrell 1990). In East Africa, farmers, traders, wholesalers and retailers have no access to storage facilities. Retailers in the Lake Zone of Tanzania sold most of their roots within 7 days of receipt while consumers stored roots for up to 14 days in the home before consumption (Kapinga *et al.* 1997).

This study shows the effect of handling of sacks of sweet potato on quality by varying sack weight, height of drop and the number of impacts received. After damage, the roots were subsequently stored at ambient conditions to determine how handling influenced shelf life.

2. Materials and Methods

2.1. Plant material

Sweet potato (cultivar SPN/0) was purchased from commercial smallholder farmers near Morogoro, Tanzania during the main harvesting season (July to August 1998). Roots were harvested by hand and covered with vines, when feasible, to protect them from direct sunlight. Farmers filled polypropylene sacks with either 50 or 100 kg sweet potato; roots were stuffed tightly into sacks and the top was covered with sweet potato vines before sealing with twine.

Experiments were in duplicate unless stated otherwise.

2.2. Sweet potato cultivar and quality assessment

The quality of 40 randomly selected roots, from either a heap of harvested roots (control) or from sacks of roots, was measured by scoring for breaks, skinning, shrivelling, rotting and cuts (Tomlins *et al.* 2000).

2.3. Effect of filling sacks on root quality.

Four polypropylene sacks were filled with 100 kg sweet potato. The quality of the roots was measured before and after filling.

2.4. Effect of the number of times a sack in dropped on quality and shelf life

Sacks of sweet potatoes weighing 50 or 100 kg were dropped one, three or six times from a height of 0.5 m.

2.5. Effect of the height that a sack is dropped on quality and shelf life

Sacks of sweet potato weighing 50 or 100 kg were dropped three times from heights of 0.25, 0.5 or 0.75 m.

2.6. Storage of sweet potatoes

Sweet potato roots were stored in open sacks under ambient conditions. The sack weight and quality (shrivelling and rotting) was assessed after 1, 3, 7 and 14 days. Ambient temperature and humidity were recorded using temperature (+/- 0.2°C) and humidity (+/- 4%) dataloggers (Tinytalk II; RS Components, UK) set to record every 10 min. The ambient temperature and relative humidity (RH) varied between 23 and 34°C (mean 26°C) and 35 and 73% RH (mean 57%) respectively.

2.7. Determination of type of injury that contributes to shelf life losses of sweet potato (SPN/0 cultivar).

The results from all the storage experiments were combined and regression analysis was used to determine influence that root damage from broken roots, skinning injury, cuts, shrivelling and rough (*Blosyrus* spp.) and sweet potato (*Cylas* spp.) weevil damage make to on losses (weight loss, shrivelling, rots) during storage.

2.8. Statistical analysis

Regressions were carried out using SPSS (version 8.0) statistical software. For regression analysis, linear models were assumed as there was insufficient data to conclude that non-linear ones were significant. All experiments were carried out in duplicate unless stated otherwise.

3. Results and Discussion

3.1. Effect of filling sacks on root quality

Filling polypropylene sacks with 100 kg roots did not significantly affect the quality of the roots.

3.2. *Effect of the number of impacts on the quality and shelf life roots sold in the markets*

Dropping sacks increased the occurrence of broken roots while the weight of the sack has no effect (R^2 adjusted = 0.602, P >0.001) (Fig. 1). Skinning injury and cuts were not affected by dropping the sack or its weight.

The number of impacts increased weight loss when the roots were stored (R^2 adjusted = 0.898; P >0.001); each impact increased weight loss by 0.25% for each day of storage (Fig. 2). The number of impacts did not influence rots and shrivelled roots when stored (data not shown).

3.3. *Influence of the height from which a sack of sweet potatoes in dropped on quality and shelf life*

The proportion of broken and skinned roots in a sack increased the higher they were dropped (Fig. 3 and 4); the weight of the sack (50 or 100 kg) had no effect. While skinning injury increased with the height of drop (R^2 adjusted 0.509, P >0.05), breaks increased to a threshold height of 0.5 m. Above 0.5 m, there was no further increase in broken roots. It is thought that the forces occurring in a sack dropped from a height of 0.5 equalled the maximum breaking strain for the roots. The wide scatter in the scores, however, suggests that dropping a sack above 0.25 m would result in significant damage from broken roots.

The height that a sack was dropped significantly increased weight loss by up to 2.6% when the roots were stored (R^2 adjusted 0.908; P >0.001) (Fig. 5). The height from which a sack was dropped did not affect the occurrence of rots or shrivelled roots.

3.4. Determination of type of root injury that contributes to shelf life losses of sweet potato (SPN/0 cultivar).

Skinning injury (R^2 adjusted 0.857; P = >0.001) and to a lesser degree broken roots (R^2 adjusted = 0.838; P >0.001) correlated with increased the weight loss during storage (Fig. 6 and 7). Roots with no skinning injury would lose weight by 1% each day. Severe skinning injury (score of 70) would account for an additional loss in weight of 3.7%.

Skinning injury (Kushman 1975; Stikeleather and Harrell 1990) has been reported elsewhere to be a major factor contributing to weight loss during storage. In Tanzania, avoiding injury to roots may improve incomes as retailers keep roots for up to 7 days before sale and consumers keep them for an additional 14 days (Kapinga *et al.* 1997). Broken and cut roots have been reported as factors that contribute to shelf life losses in sweet potato (Onwueme 1978; Medlicott 1990; Woolfe 1992; Kapinga *et al.* 1997).

Skinning injury also made the roots significantly more susceptible to rots during storage (R2 adjusted = 0.178; P = >0.001) (fig. 8). Skinning injury has been reported to make sweet potatoes more susceptible to rots (Stikeleather and Harrell 1990). The wide scatter of the data, however, suggests that rots are influenced by additional factors. Broken and cut roots did not influence rots.

4. Conclusions

The height and number of drops reduced the quality of sweet potato (SPN/0 cultivar). The occurrence of broken roots increased with both height and number of times a sack was dropped while skinning injury increased with height. The weight of the sack (50 or 100 kg) had no influence of quality. The shelf life, indicated by weight loss, was most influenced by the height that a sack was dropped and to a lesser extent the number of drops. Of the classes of injury (weevil, cuts, skinning, breaks, shrivelling) sustained by sweet potatoes during handling, skinning injury, and to a lesser degree broken roots, correlated most with weight loss.

Reduced handling of sacks of sweet potato will improve the their marketability and returns to farmers and extend the shelf life by reducing skinning injury and broken roots. A simple intervention by reducing the weight from the current 100 kg to 50 kg did not reduce damage. The use of alternative methods of packaging (cardboard and wooden boxes) may lead to improved quality; this needs to be investigated under actual conditions. Furthermore, pre-harvest curing of the roots (Bonte and Wright 1993) by pruning the plant canopy up to 14 days before harvest has been reported to reduce the injury to roots during handling and transport by facilitating wound healing. Pruning is not widely practised in Tanzania and East Africa and may offer a simple and low-cost technique for reducing susceptibility to injury. This deserves further investigation.

Acknowledgements

his publication is an output from a research project funded by United Kingdom Department for International Development (DFID) for the benefit of developing countries. The views expressed are not necessarily those of DFID *[R6508: Crop Post-Harvest Research Programme]*.

REFERENCES

Anon., 1999. CIP Sweetpotato Facts: A compendium of key figures and analysis for 33 important sweetpotato-producing countries – Production, Utilisation, Consumption, Feed Use. International Potato Center, Lima, Peru.

Bonte, D.R., Wright, M.E., 1993. Image analysis quantifies reduction in sweet potato skinning injury by preharvest canopy removal. HortScience. 28, 1201.

Curtis, V., 1986. Women and the transport of water. Intermediate Technology Publications, London, ISBN 0946688427. 54p.

Dennis, R., Smith A., 1995. Low-cost, load-carrying devices, Intermediate Technology Publications. London, ISBN 1853392650, 192p.

Kapinga, R.E., Rees, D., Jeremiah, S.C., Rwiza, E.J., 1997. Preferences and selection criteria of sweet potato varieties in urban areas of the Lake Zone of Tanzania. Technical Report, Natural Resources Institute, Chatham, UK.

Kushman, L.J., 1975. Effect of injury and relative humidity during curing on weight and volume loss of sweetpotatoes during curing and storage. HortScience. 10, 275-277.

Onwueme, I.C., 1978. The tropical tuber crops –yams, cassava, sweet potato and cocoyams. John Wiley and Sons, Chichester, UK, 182p.

Medlicott, A.P., 1990. Product specifications and post-harvest handling for fruits, vegetable and root crops exported from the Caribbean, Fintrac Technical Services, Birmingham, UK, pp77-82.

Stikeleather, L.F., Harrell, K.P., 1990. Sweetpotato damage as measured by weight loss, Paper - American Society of Agricultural Engineering, St. Joseph, Michigen, USA, No 90-1614, pp1-10.

Tomlins, K.I., Ndunguru, G., Rwiza, E., Westby, A., 2000. Post-harvest handling and transport of sweet potatoes and their influence on quality in Tanzania, Journal of Horticultural Science and Biotechnology, [accepted for publication].

Woolfe, J.A., 1992. Sweet potato an untapped food resource, Cambridge University Press, Cambridge, UK, ISBN 052140295, 643p.

Figure 1. Relationship between number of impacts from a height of 0.5m of sacks of sweet potato and broken roots (total score)

Figure 2. Influence of impacts on the weight loss during storage

Figure 3. Relationship between breaks sustained by sweet potato roots and the heights from which they were dropped

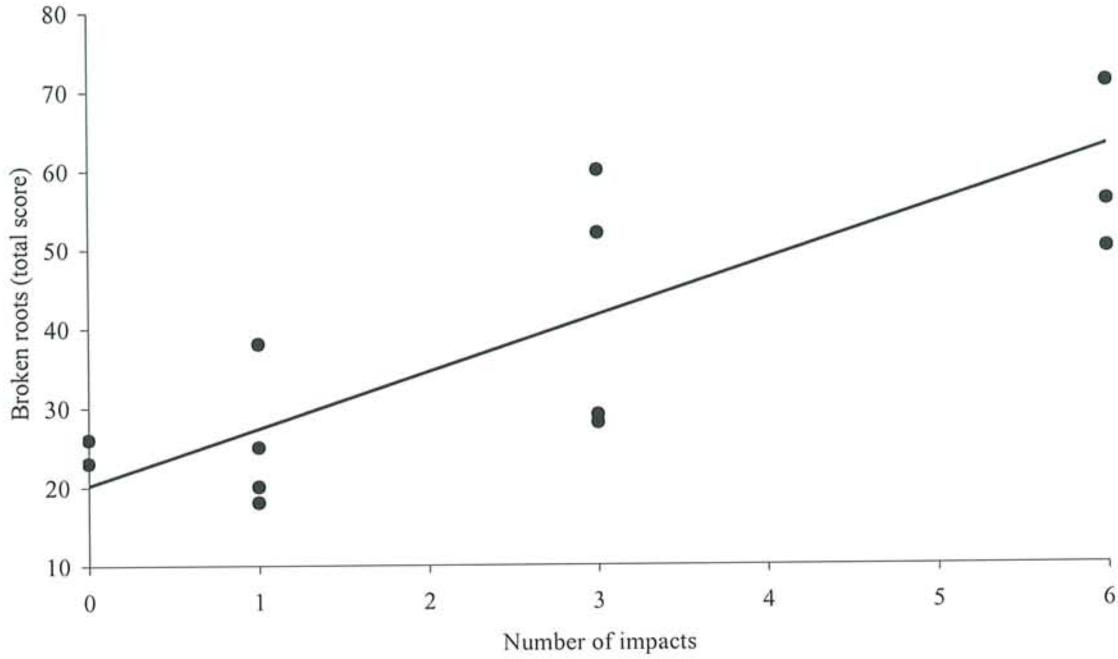
Figure 4. Influence of height of drop of sacks of sweet potato on skinning injury

Figure 5. Influence of height of drops and storage time on weight loss (%) of sweet potatoes

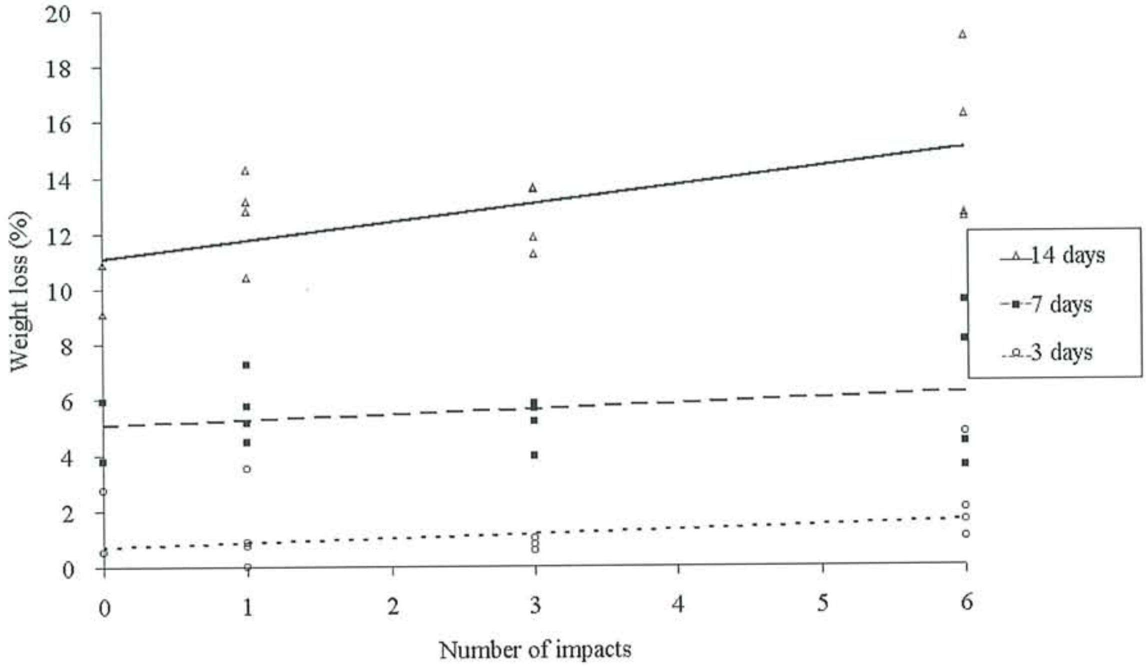
Figure 6. Effect of skinning injury incurred during experimental trials on weight loss (%) during storage at ambient temperature and humidity

Figure 7. Effect of broken roots incurred during experimental trials on weight loss (%) during storage at ambient temperature and humidity

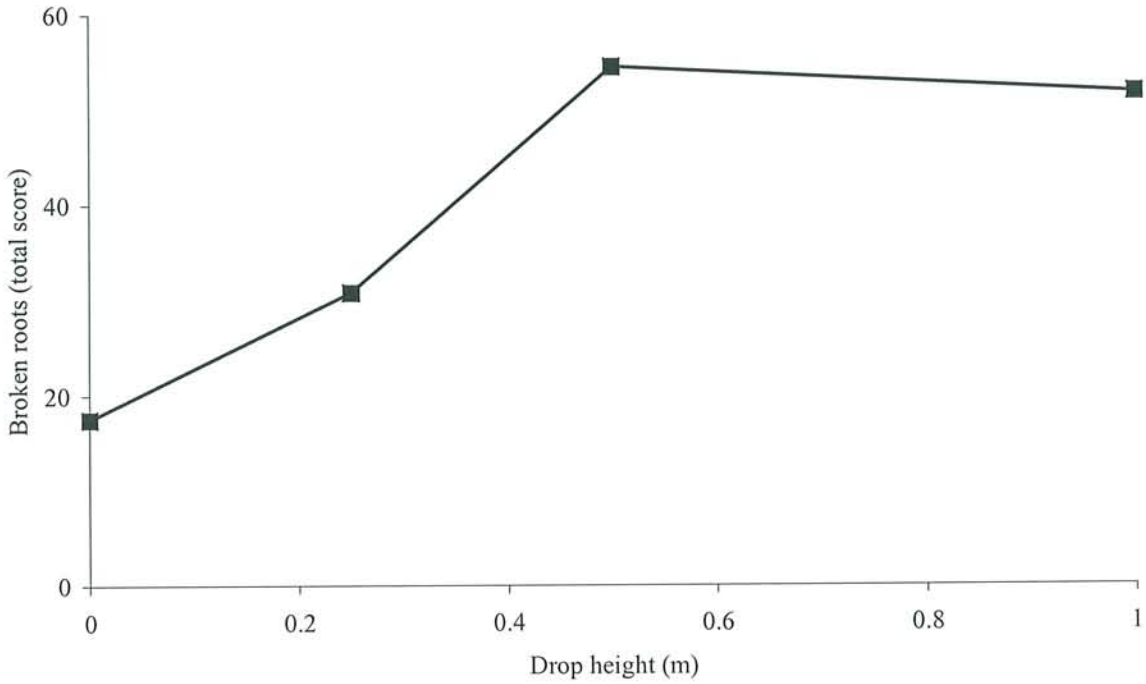
Figure 8. Effect of skinning injury incurred during experimental trials on rots (total score) during storage at ambient temperature and humidity



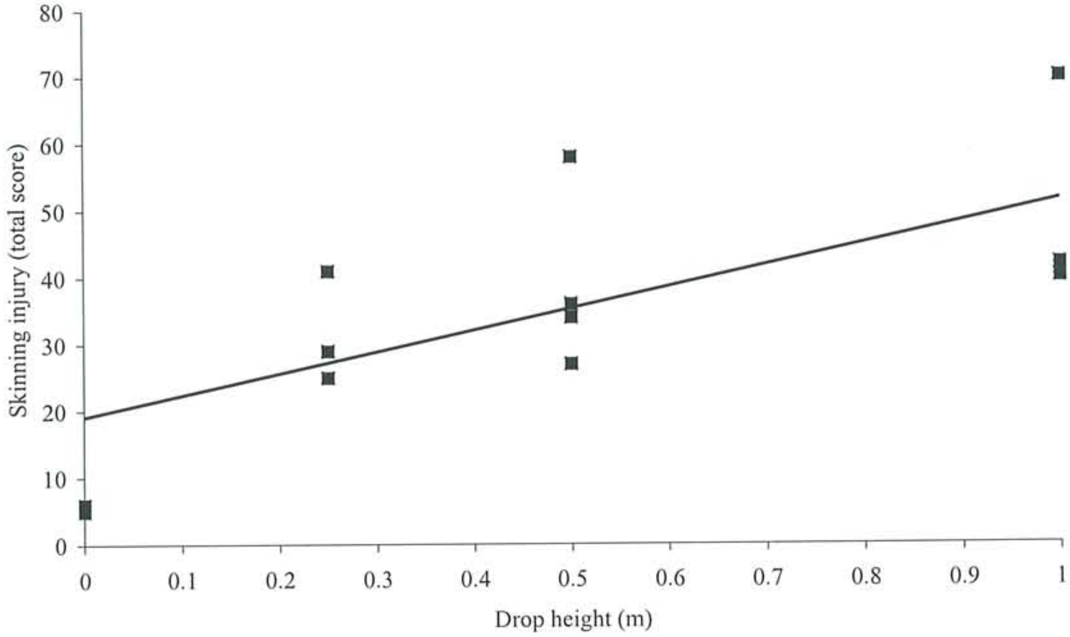
Where: broken roots (total score) = (number of impacts x 5.881) + 22.197



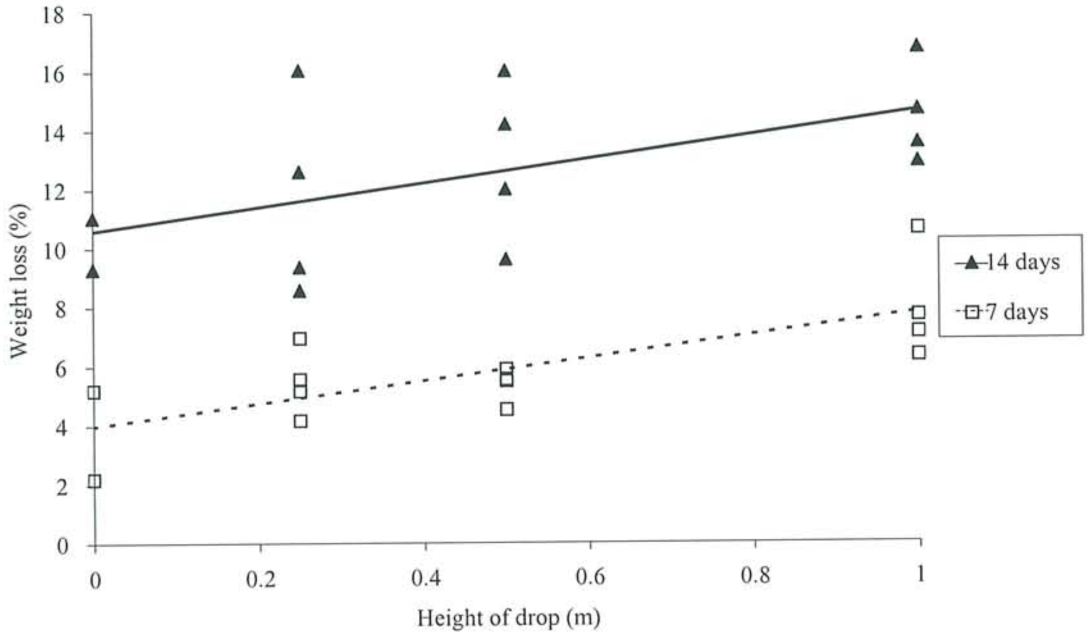
Where: weight loss (%) = (number of drops x 0.251) + (storage time in days x 1.023) –2.184



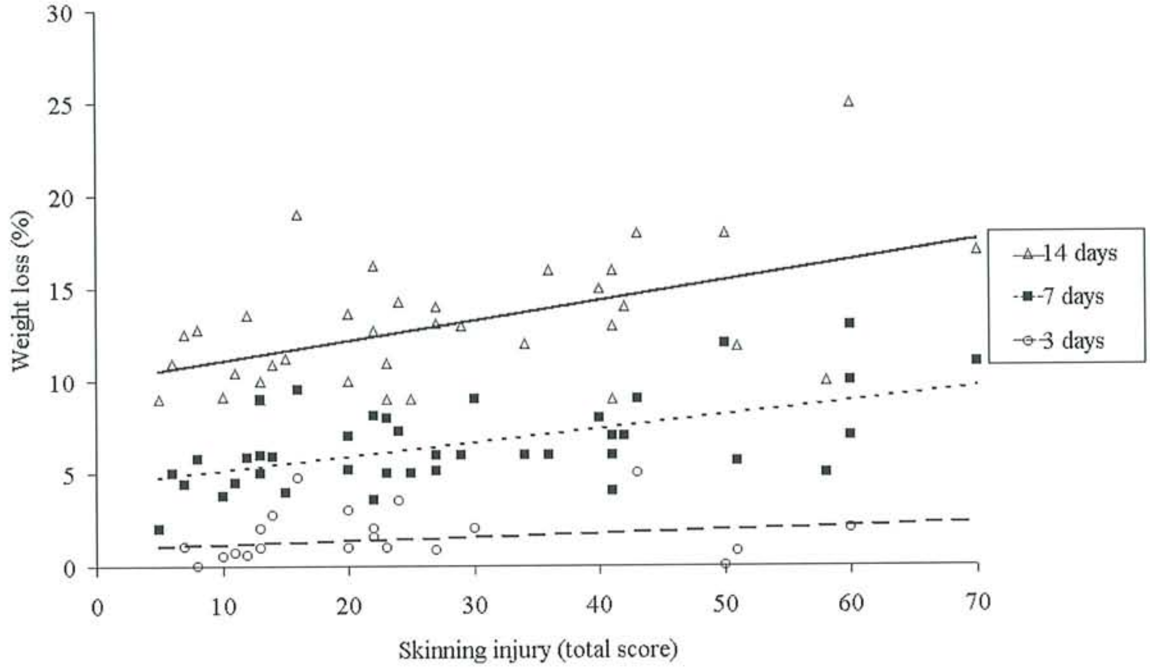
Where each reading is the mean of sacks



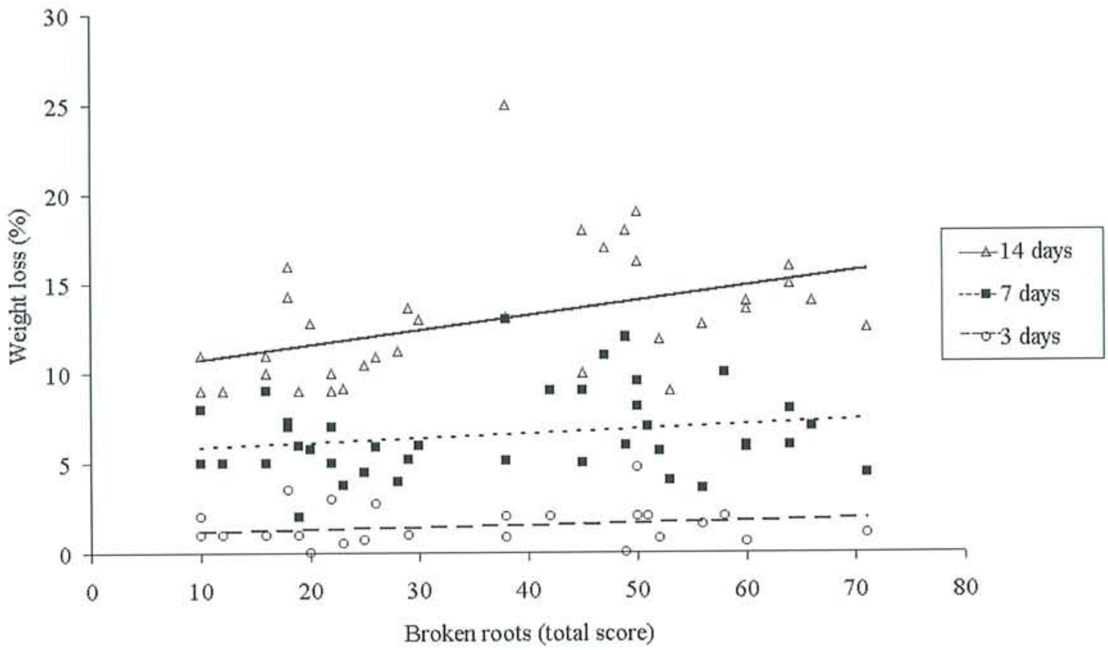
where: skinning injury (total score) = (height of drop in metres x 32.571) + 19.071



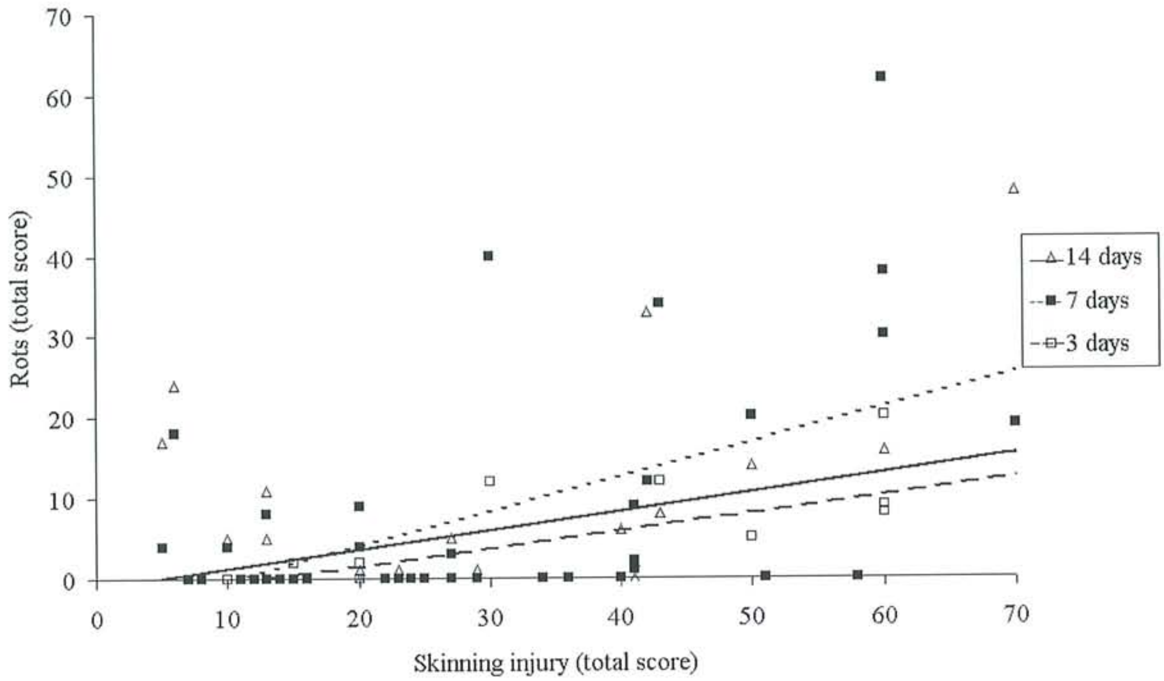
Where: weight loss (%) = (Height of drops x 2.633) + (storage time in days x 0.970) – 2.264



Where: weight loss (%) = (skinning injury x 0.0531) + (storage time in days x 1.014) – 2.536



Where: weight loss (%) = (broken roots x 0.011) + (storage time in days x 1.013) – 2.221



Where: rots (total score) = (skinning injury x 0.223) + (storage time in days x 0.410) – 4.780