Quality assessment of anti-shock systems for potatoes

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Summary

Loading trailers and trucks includes a high risk for mechanical damage to potatoes, particularly when no anti-shock system is used. Manufacturers offer anti-shock equipment to reduce mechanical damage. A selection of anti-shock systems was compared.

Firstly, the effect of protecting the product layer at the bottom of the trailer was investigated by dropping tubers in the empty trailer and analysing tissue discolouration and cracks. The combination of a shock absorber and a mattress yielded the highest bruise protection. Secondly, to investigate the bruising profile in the trailer and the damage reduction effect of each anti-shock system a bulk mass of potatoes was dumped into the trailer. Five hundred test potatoes were mixed into the bulk mass. Test potatoes were visually analysed for bruising and compared with controls (anti-shock systems absent). The results allowed the introduction of a mathematical relationship between drop height and tissue discolouration. Using an anti-shock system bruising was reduced by 10–90%, depending on the system and the bulk layer.

On-field experiments were carried out to validate laboratory results. However, site-specific harvest conditions and variable commodity properties made comparisons difficult.

Introduction

The unloading of potatoes from harvesters into trailers and lorries creates a high level of risk of mechanical damage to potatoes. Frequently observed types of damage include cracks, crushed tissue and internal discolouration, which adversely affect the quality of potatoes. In many handling machines potatoes suffer numerous small to moderate shocks due to slight differences in height between successive machine parts (Baheri, 1997; Molema, 1999). When potatoes are tipped in trailers and lorries, however, they may fall great distances — ranging between 0 and 2 m — and suffer intense shock. Anti-shock systems provide solutions to the problem by reducing drop height or absorbing energy from tubers. They can be defined as all devices or materials able to reduce drop heights or to absorb impact energy of falling potatoes. Due to the importance of the unloading process in the mechanised potato handling chain and since manufacturers offer different kinds of anti-shock systems, a comparative quality test was carried out for a selection of systems, frequently used in practice.
The principal aims of this study were:
- to investigate the bruise reduction effect of anti-shock systems in the bottom layer of a tipping trailer;
- to determine the bruise reduction capacity of anti-shock systems in well-defined layers of a tipping cone;
- to evaluate the system or combination of systems with the best overall bruise reduction capacity;
- to determine the gradual decrease in bruising with increasing height of the tipping cone and to establish a mathematical expression between height of the tipping cone and bruising for the reference situation (a tipping trailer without anti-shock system).

In this research bruising or bruise damage reported includes all mechanical damage to potatoes (shatter, cracks, internal crushes, tissue discolouration) associated with shocks absorbed during the loading process in a trailer. Visual analysis of potato samples allowed determination of the bruising index $I_D$, a parameter frequently used in Belgian potato bruise research (Ampe, 1991; Leicher, 1992; Nerinckx & Verschoore, 1993; van Canneyt et al., 2004).

Materials and methods

Test equipment

Trailer adaptations. To obtain comparable results for all anti-shock systems a commercial tipping trailer type was furnished with a double steel bottom and sides. All systems could easily be installed and removed in the trailer. The trailer was furnished with mounting holes in the bottom plate for all three mattresses and three series of fixation points at the sides to enable shock absorber mounting at three different heights (1 m, 1.20 m and 1.30 m from the bottom). Fig. 1 shows a view of the double loading container with a detailed drawing of the shock absorber fixation points. Fig. 1 also shows the container's dimensions in front view. Total length of the container was 4.20 m and it was made to fit in different commercial trailers.

Anti-shock systems. Cooperating manufacturers supplied three shock absorbers with rubber straps, three mattresses and a stop-shock system. Since the shock absorbers were similar to each other in dimension and material construction, only one shock absorber was selected for the experiments.

The shock absorber consisted of 50 mm wide rubber straps with an alternating length of 1700 and 1800 mm. The 26 straps had a thickness of 8 mm and consisted of two rubber layers enclosing one layer of linen. Between the straps there is an open space of 25 mm. On both sides the straps were clasped between two steel bars (2000 mm long, 45 mm wide and 8 mm high). The shock absorber was attached in the trailer by 6 chains with a mutual distance of 750 mm.

The three mattresses were all made of polyethylene foam and were covered with a synthetic canvas of polyethylene or polyvinylchloride. They differed from each other by density, foam thickness and dimensions. Table 1 gives the design parameters.