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HARVEST AND STORAGE OF POTATOES IN BOXES

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Abstract: Often the potatoes are filled in storage boxes in field by the hopper of the harvester ("indirect box filling"). A high concentration of foreign material in the middle of the box is the result. To avoid mechanical loads on potatoes a special device for filling and transfer of pallet boxes was mounted on a potato harvester Grimme SE 150-60 ("direct box filling"). The question was how filling the boxes on the harvester affects the distribution of the foreign material in the box.

Potato boxes which were filled by direct and indirect box filling method were tipped out on a tipping station and the distribution of foreign material was determined. On a ventilation test rig the influence of the foreign material distribution on the air flow was investigated.

The boxes showed a variation coefficient of 46.6% for direct box filling, which was half that of indirect box filling (93.8%). The indirect filling included more loose soil than the direct filling because of disintegration of clods during the filling process. In case of direct box filling ventilation air flow even through the middle of the boxes was possible due to a very uniform distribution of loose soil.

Key words: *potato, harvesting, storage, boxes.*

INTRODUCTION

In Germany table potatoes are stored loose in boxes or bulk stores. About 41% of store keepers use boxes to store table potatoes [1]. These farmers are aiming at a reduced mechanical load on the tubers.

Often the potatoes are filled in the storage boxes by a box filler on farm. This process includes a lot of mechanical impacts by handling, transport and storage. Therefore, farmers are tending to fill the potatoes into storage boxes immediately after harvesting [2, 3, 4]. The boxes are brought to the fields in transport vehicles and are filled by the harvester hopper. This method is called hereinafter "indirect box filling". Examinations of the distribution of foreign material have shown [5], that there was more than 30% more foreign material in the middle of the box than at the front and back side of the box if the boxes were filled from the hopper of the harvester. It can be assumed, that the foreign material in the middle of the box effects negatively the ventilation.

As already reported in a previous paper [6], a 2-row harvester Grimme SE 150 - 60 was equipped with a device for filling and transferring storage boxes on the harvester (Fig. 1). This process is described below as "direct box filling". The tubers are conveyed to the store in the boxes and taken into storage without any further tuber handling processes.

When the boxes are filled on the harvester, the box and feed belt are displaced in relation to each other several times (Fig. 2) so that the box is filled evenly in layers. As a consequence of this filling method it could be expected that the foreign material would not accumulate in the middle of the box, but instead that tubers and foreign material would be spread uniformly throughout the box.

The aim of our investigation was to clarify how filling the boxes on the harvester affects the distribution of the foreign material in the box.

Fig. 1. Harvester Grimme SE 150 -60 with a device for filling and transferring the box (developed by Schoepstal Maschinenbau GmbH [7])

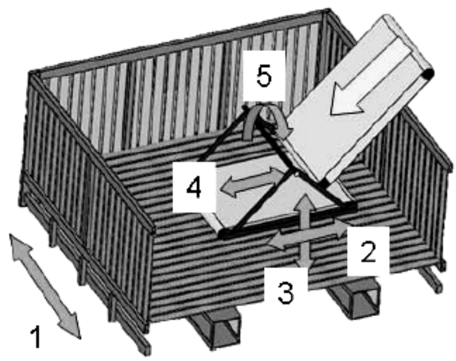

Fig. 2. Box filled in layers by displacing the box (1) and filling belt (2), increasing the height of the filling belt (3), reversible conveyor device (4), adjustable angle of inclination (5)

MATERIAL AND METHODS

Our own investigations aimed to determine the distribution of foreign material inside the box for both direct and indirect box filling. The examinations were conducted in connection with practical trials of a Grimm SE 150-60 harvester with a box-filling facility [6, 7]. The harvester trials and examinations of foreign material distribution were conducted at Friweika Weidensdorf e.G. (Germany, Saxony). The company has storage capacity for approx. 30,000 t potatoes, including 15,000 t in boxes.

Five potato batches were selected for the examinations. In order to achieve comparable measuring conditions for the two box filling processes, the two methods – direct and indirect - were always applied on the same field at the same time. Thanks to good lifting conditions, the share of foreign material in the tuber batches was below 5%.

On a tipping station, in the years 2003 and 2004 altogether 40 boxes each with 4 t potatoes were tipped empty and the distribution of the foreign material was examined. Each tuber batch consisted of 8 boxes, in other words 4 boxes from direct filling and 4 boxes from indirect filling. The tipping line (Fig. 3) consisted of a tipping station (2) and a wide discharge belt (3), 5 m long and 2.7 m wide. After the boxes were tilted at the tipping station, the tubers were tipped from the box onto the slow-moving discharge belt, so that the harvested material spread over the entire length of the conveyor belt. The harvested material fell from this conveyor belt over 4 steel rollers (4) onto a belt running crossways (5). Thanks to the orderly emptying and distribution of the tubers on the discharge belt (3) it was possible to subdivide the mass of tubers lying on the belt into 12 hypothetical sections (A - L). Each section corresponded to one section in the filled box prior to tipping. The rollers (4) at the end of the discharge belt were arranged at clear intervals of 2 cm. When the tubers were transported over the rollers, foreign material with a diameter of up to 2 cm fell between the rollers and was caught in three containers (6).

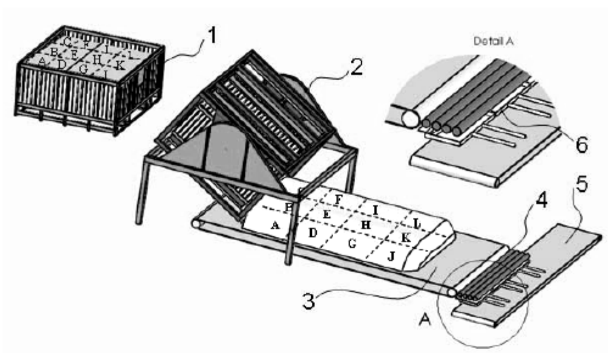

Fig. 3. Schematic structure of the experimental arrangement on the tipping station (1) Storage box with the sections marked, (2) tipping station, (3) discharge belt with the sections marked, (4) steel rollers for removing soil, (5) cross conveyor belt, (6) containers for collecting the separated soil

For the evaluation a mean value, a standard deviation, and a variation coefficient were formed jointly for the 4 boxes per process variant from the proportions of foreign material Ø < 2 cm in the 12 box sections.

In a laboratory experiment it was interesting to ascertain how the spatial distribution of the foreign material in the box influences the flow profile. A square container with a length of 1300 mm, a width of 1175 mm and a height of 600 mm and closed sidewalls was used for the experiment (Fig. 4). The container was filled with 500 kg potatoes. The surface of the potato pile was divided into 36 subsections with a surface area of 200 x 180 mm. The airflow through each section was measured with the aid of a measuring hopper with built-in thermo anemometer (Lambrecht 642 ST, resolution 0,01 m/s) (Fig. 4).

In order to be able to translate the investigation results into practice, the examinations concentrated on two variants of foreign material distribution:

- Variant 1: 25 kg loose soil (soil content of 5%) was added uniformly to the tubers when filling the box.

- Variant 2: 25 kg loose soil (soil content of 5%) were filled in the middle of the box.

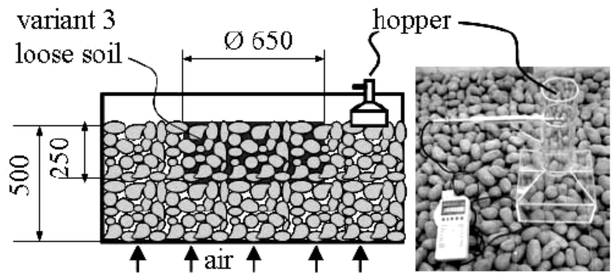

Fig. 4. Ventilation test rig with square container and hopper for measuring low air velocities

RESULTS AND DISCUSSION

The tipping method showed clearly that in direct filling the foreign material was distributed more uniformly over the box area than in the case of indirect box filling (Fig. 5a, b). The mean value of the boxes showed a variation coefficient of 46.6% for direct box filling, which was half that of indirect box filling (93.8%).

If the share of foreign material in direct filling is set at 100%, then indirect filling reaches a value of 142.4%. This means that in indirect filling substantially more foreign material with Ø < 2 cm was found, although both filling variants were applied on the same field at the same time with the same type of harvester. The higher mechanical stress on the harvested material during the filling process is thought to be the reason for the higher proportion. When the hopper is filled and the harvested material is transferred from the harvester hopper to the boxes, the tubers with adhering soil and the clods bang and rub against each other. When this happens part of the soil adhering to the tubers becomes detached and some clods disintegrate. Ultimately the share of foreign material with Ø < 2 cm increases.

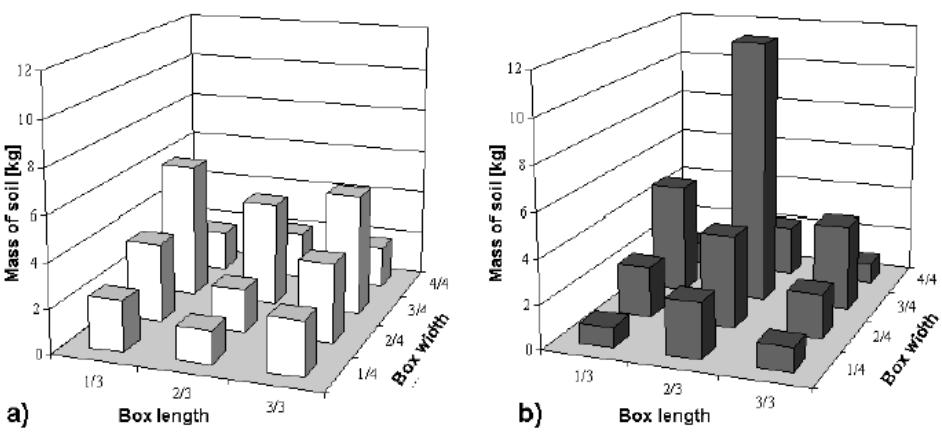

Fig. 5. Distribution of the foreign material Ø < 2 cm in the direct (a) and indirect (b) filled boxes, mean value of four measurements, variety Princess

If potatoes and foreign material were distributed uniformly in the box as with direct box filling, a relatively uniform flow profile was found over the box cross section (Fig. 6). Air also flowed through the middle of the box, but the edge/corner influence dominated in the flow profile. At the edge of the box and in the box corners the airflow reached maximum values due to the large pore volume between the box wall and the adjacent tubers.

In the case of indirect box filling hardly any or no air flowed through the middle of the box with the foreign material. This result was obtained by a share of foreign material of only 5%.

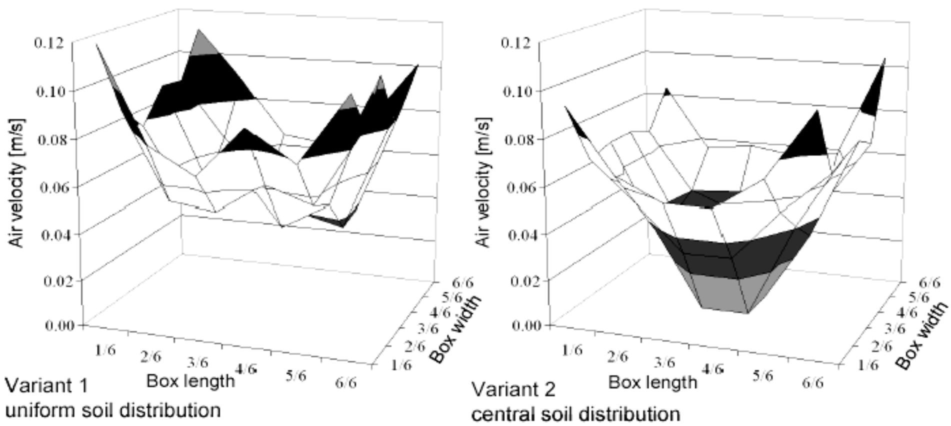

Fig. 6. Flow profile at an air velocity of 0.08 m/s in the free container cross section by 5% soil content

CONCLUSIONS

If foreign material cannot be avoided when potatoes are taken into storage, then at least uniform distribution of the foreign material is to be targeted. By filling the boxes on the harvesting machine, foreign material is distributed uniformly and as a result the boxes are filled in a manner favourable for ventilation.

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UBIRANJE I SKLADIŠTENJE KROMPIRA U DRVENE KONTEJNERE

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Sadržaj: Čest je slučaj da se krompir, odmah na parceli, utovarivačem puni u sanduke i kao takav transportuje u skladište. Ovakav slučaj se još naziva i "indirektno punjenje sanduka". Kao rezultat ovakvog pakovanja, javlja se velika količina primesa u središnjem sloju krompira. Da bi se izbegla mehanička oštećenja krompira, poseban uređaj je postavljen na kombajn za ubiranje krompira Grimme SE 150-60 (sistem "direktnog punjenja"). Pitanje koje je postavljeno je kako punjenje sanduka na samom kombajnu utiče na prisustvo primesa u samom sanduku.

Drveni kontejneri su bili punjeni krompirom kako direktnim sistemom tako i indirektnim. Posle punjenja određeno je prisustvo primesa. Takođe je urađeno i ispitivanje kako distribucija primesa utiče na protok vazduha u kontejnerima.

Koeficijent varijacije kod kontejnera je bio 46,6% za direktni sistem punjenja. Kod indirektnog sistema njegova vrednost je bila 93,8%. Kod indirektnog sistema punjenja uočena je veća količina sitne zemlje u odnosu na direktni sistem. U slučaju direktnog sistema punjenja protok vazduha je ostvaren čak i u središnjem delu kontejnera, obzirom da su sitne primese bile dobro raspoređene.

Ključne reči: *krompir, ubiranje, primese, skladištenje, drveni kontejneri.*