Quantitative Evaluation of Handling Damage to Sugarbeets

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## INTRODUCTION

Sugarbeet roots are often severely damaged by impacts received during harvesting, handling, cleaning, and piling. At the present time, the relationship between the impact energy and the resulting damage is unknown. In view of this, a series of tests were conducted to more accurately quantify physical injury to sugarbeets. A natural frequency vibrating conveyor for removing dirt from sugarbeets and sorting them according to size has been designed and constructed.

## IMPACT STUDIES

Sugarbeets were subjected to controlled impacts in order to quantitatively assess the effects of impact damage. The beets (commercial variety) were hand harvested from USDA plots on the MSU campus. They were hose washed and were topped such that about 95% of the leaf scar material was removed. Beets selected for the trials had approximately the same area of cut surface that resulted from topping.

Impacts were delivered by a shock testing machine which consisted of a table capable of being raised to preset height and a base upon which the table was dropped. A braking system arrested the table upon rebound so that only one impact occurred. A shock programmer placed between the table and the base controlled the type of shock--for these tests a programmer giving a sine shaped impact was installed.

A fixture which simulated the rod bed of the natural frequency vibrating conveyor was fastened to the table. The fixture consisted of two parallel 0.5 inch diameter steel rods positioned 2.75 inches on center. One of the rods was covered with a cushioning material so that most of the energy of impact was absorbed by the portion of the beet in contact with the remaining rod. The individual beets were secured in place on the fixture prior to dropping the table.

Immediately after washing and topping, the beets were randomly divided into four groups of seven beets each, each group then given a predetermined treatment. The 4 inch drop height together with the sine wave programmer created a peak shock level of approximately 160 g's with a pulse width of about 3.5 ms. Since the coefficient of restitution of sugarbeets is unknown, the equivalent theoretical free fall height could not be calculated exactly. Nevertheless, this shock level consistently produced a hairline fracture from 1 to 2 inches in length in the beet surface near the point of impact. After each drop, the beet was rotated so that no two impacts were delivered to the same point on the beet surface.

The treated beets were placed in the APRIL (Dilley, 1968) system (Horticulture Department, Michigan State University) to monitor the respiration rate in air at 20 C. Each sample consisting of one beet was analyzed every 12 hours over an 84-hour period. The results of the analyses conducted by Dr. D. R. Dilley, Horticulture Department, are shown in Figure 1.

Prior to this experiment it was felt that the hairline fractures (some of which were barely visible) that constituted the damage to beets in groups 2 and 3 (see Table 1) would not affect respiration rate. However, the results of Figure 1 show that such fractures do indeed have a measurable effect on respiration, in fact the beets which were subjected to eight impacts showed almost the same increase in respiration as beets which were sliced in half. Thus, it is not sufficient to assess the damage imparted to beets by harvesting, handling, cleaning, and piling equipment on the basis of broken beets alone. Fractures in the beet surface, although barely visible but of sufficient number, can be equally important as a factor contributing to increased respiration.

Table 1. Damage Levels to Individual Beets Placed in Respiration Chambers

| Group No. | Treatment |
|---|---|
| 1 | Control |
| 2 | 3 drops with 4 inch drop height* |
| 3 | 8 drops with 4 inch drop height* |
| 4 | Sliced in half |

*Equivalent to a theoretical free fall height of 6.2 inches and 25 inches for a purely elastic and a purely plastic body, respectively.

## NATURAL FREQUENCY VIBRATING CONVEYOR

The natural frequency vibrating conveyor consists of a bed, made of spaced rods, and a mechanism for driving the bed. The bed oscillates through a preset angle with the horizontal. A sugarbeet will lift off from the bed whenever the acceleration of the bed in the vertical direction exceeds acceleration due to gravity. Removal of dirt depends upon the impact resulting from the beets return encounter with the bed. Also, because bed acceleration has a horizontal component, the beet will move along the bed. Three parameters determine the magnitude and number of impacts: (i) length of stroke, (ii) angle, and (iii)frequency of vibration. This control over impact allows maximum dirt removal with minimum beet damage.

The vibrating conveyor has been tested in prototype form for dirt removal and sorting beets according to size. The conveyor effectively separated field soil from sugarbeet roots while inflicting less physical damage to the roots as compared to the grab roll system. Mechanical impact was responsible for the cleaning, but the degree of damage was limited since the magnitude of the impact was controlled.

## LITERATURE CITED

Dilley, D. R., D. H. Dewey and R. R. Dedolph, 1969, Automated system for determining respiratory gas exchange of plant materials. J. Am. Soc. Hort. Sci. 94, 138-41.

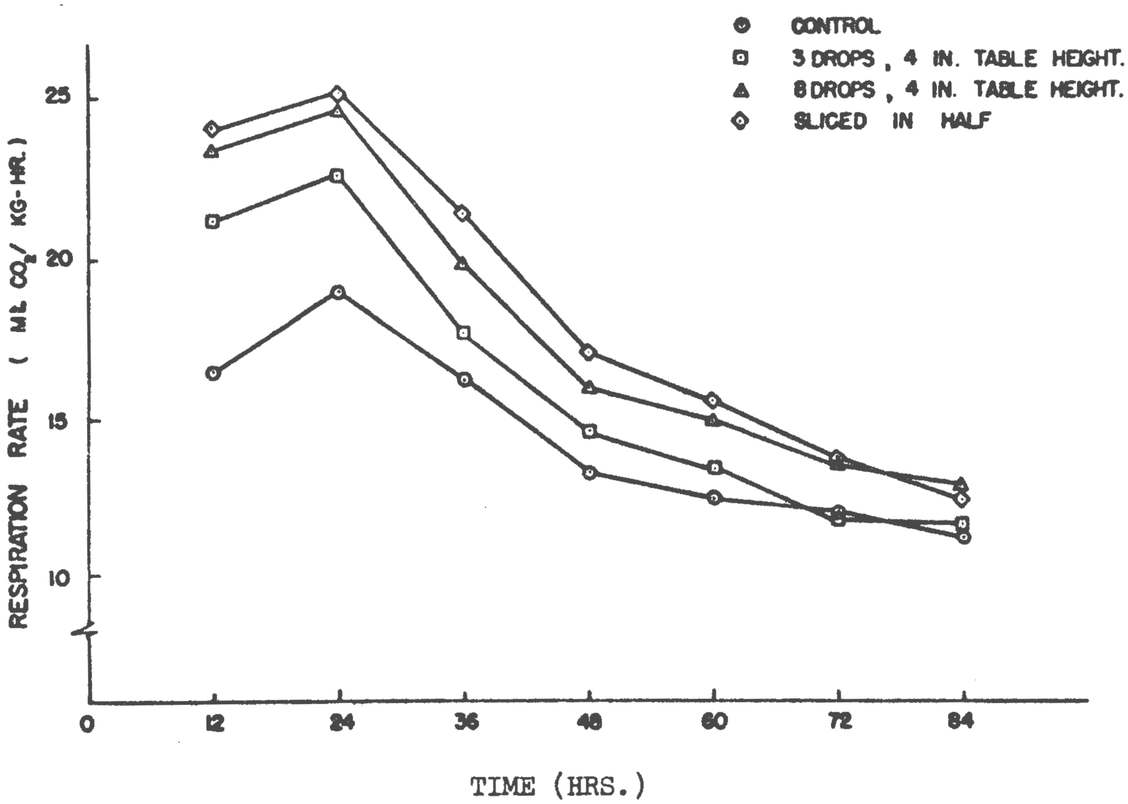


Figure 1. Respiration Rate of Sugar Beets

DISCUSSION

Wyse: How much variability do you get from year to year between varieties? Is their ranking consistent from year to year?

Watkins: If they are grown in the same area, it stays pretty much the same. Where we find differences is between locations. For example, in 1969 we had one variety harvested in Kansas and at two locations within 10 miles of each other near Rocky Ford. There was tremendous differences among these three areas and even between the areas near Rocky Ford. I have no explanation for this.

Oldemeyer: You indicated you could see no difference between covered and uncovered piles. Did you have any temperature data to see how these compared.

Watkins: We did have temperature data and this is where we came up with 36 F for our controlled conditions. Between the covered and non-covered, the temperature was not much different.

Fox: In our pile-covering tests, we picked up tremendous differences in storage directly under the cover, while in the middle of the pile, covering has very little effect. This is assuming you don't do anything detrimental by covering, such as making it too warm. The savings occur on the rim and since your samples were in the middle, you may not have detected this savings.

Oldemeyer: Whenever you put plastic on the sides of the pile you are changing the entire circulation pattern. Therefore, there has to be a difference in the temperature patterns within the pile.

Fox: Yes, we have observed those differences and more often than not we have hurt ourselves in the middle with the cones. But it does make a tremendous savings on the rim.

Wyse: Did I understand you to say that herbicides affected water loss during storage?

Watkins: Yes and this is something we don't understand. The control lost almost twice as much weight as did the herbicide treated roots.

Wyse: Do you see any possible means, chemical or otherwise, for reducing massive mold invasion in a pile?

Bugbee: In the use of chemicals one always has the residue problem. Lime has been sprayed on piles, but was not of significant value. I personally do not know of a method to reduce massive mold growth.

Oldemeyer: You mentioned finding quite a number of Phoma resistant roots in Rhizoctonia resistant material. Would you say there is a correlation in resistance?

Bugbee: It is a possibility that the resistance mechanism to Rhizoctonia is similar to the one working against Phoma. But again, it may not be the same because only a small portion of the $F_2$ lines were resistant.

Question: You actually only dropped the beet four inches.

Bickert: The beet was mounted on a fixture which was fixed to a table and then the table was dropped onto a sine-shaped wave programmer. The equivalent height, guessing from the coefficient of restitution of the root, would be 12 inches.

Fox: Did you ever check to see if you increased respiration by passing the beets over your shaker screen device.

Bickert: No, but as a matter of fact the fixture to which the beet was fastened in the dropping test was part of the shaker screen. So when the beet dropped what it actually hit was the shaker bed.