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ELECTRONIC PENDULUM MIDAS 88P*

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A b s t r a c t s. An Electronic Pendulum MIDAS 88P was used for determination of damage susceptibility of potatoes, sugar beets and apples. The main principle of the pendulum is to use a first and a second impact at the same site of testing material. For classification of damage of testing material a Damage Index (DI) was defined. The pendulum parameters Pendelum Index (PI) and absorbed energy of second impact (E2) correlate with damge Index (DI).

K e y w o r d s: electronic pendulum, damage susceptibility, potato, sugar beet, apple

INTRODUCTION

For 25 years pendulums are used for the determination of damage susceptibility of potato tubers in potato research and potato breeding. The electronic pendulum MIDAS 88P has been built in a series of about 60 devices. It has been used for 5 years.

The pendulum can also be used for the determination of damage susceptibility of other agricultural products. The pendulum must be adapted in this case.

MATERIALS AND METHODS

Pendulum

The pendulum consists of three units: mechanical recording, and analysing one.

The first has a holding mechanism for the agricultural object with a counter-weight, the pendelum with exchangeable head to impact objects and two permanent magnets at the bottom, a holder disc with an electromagnet to keep the pendulum in its initial position. Near the dead centre on the pendelum a hall-sensor is placed.

If an object is impacted, time measurements before and after impacts are used to determine kinetic energy of the pendulum.

The recording and analysing unit includes a printed circuit board, it controlls the work of the operator, records and analyses the data, and displays the results.

The pendulum works in the range of energy levels from 0 to 370 mJ. It is possible in research work to vary the input-energy and change the heads for each problem. The main principle of the pendulum is to use a first and a second impact at the same site of testing material. The first impact forms the texture. The second is more accurate for the determination of absorbed energy.

In assessment of measurements with pendulum four results are usable:

- *PI* Pendulum Index

$$PI = \frac{100}{n} \sum_{i=1}^{n} K_i \qquad (1)$$

* This work was carried out in cooperation with B. Zachow, WIP - Research - Station Gross Lüsewitz of Rostock University, Germany.

where $K_i = 1$ when absorbed energy of second impact < absorbed energy of first impact and $K_i = 0$ absorbed energy of second impact > absorbed energy first impact,

- E_2 - the average absorbed energy of second impacts and the variation coefficient,

- E_1/E_2 - the average ratio of energy values of first impacts/second impacts and the variation coefficient,

- $E_1+E_2/2$ - the average loss energy of all impacts and the variation coefficient.

Classification of damage

After 4 days a vertical cut through the point of impacts of the measured objects is carried out. Following categories are used for assessment of affected tubers:
Note 1 undamaged,
Note 2 damage of depth up to 2 mm (n2),
Note 3 damage of depth between 2-5 mm (n3),
Note 4 damage of depth between 5-8 mm (n4),
Note 5 damage of depth greater then 8 mm (n5).
Definition of Damage Index *DI*:

$$DI = 100\,(0.2\,n2 + 0.4\,n3 + 0.7\,n4 + 1.0\,n5\,) \text{ /number of sites.} \quad (1)$$

TESTS AND RESULTS

Three examples of tests were shown:

1. Potatoes: 10 cultivars of a field experiment in Gross Lüsewitz with 50 tubers were tested in each case with 2 double-impacts with a kinetic impact energy of 150 mJ and a head diameter of 7 mm (Table 1).

2. Sugar beets: 5 beets of 3 sites of crop production in 1992 on 4 layer were tested in each case with 6 double-impacts with a kinetic impact energy of 220 mJ and a head diameter of 6 mm (Table 2).

3. Apples: 7 cultivars with 6 apples of a crop production in 1992 were tested in each case with 6 double-impacts with a kinetic impact energy of 45 mJ and a head diameter of 7 mm (Table 3).

The physical parameters *PI* and E_2 of the potato test gathered with the pendulum MIDAS 88P correlate very closly with the susceptibility scores after a vertical cut through the impacted site and the resulting *DI*.

Table 1. Potatoes

Cultivar	PI	E_2	DI
Kardal	100	71.0	18
Rebecca	98	70.4	15
Karnico	96	71.0	14
Vebeca	93	73.2	22
Astarte	93	71.8	17
Indira	85	73.6	30
Maxilla	76	74.7	34
Agria	72	75.2	35
Herkules	69	75.9	41
Vebesta	44	82.8	60
Correlation			
PI	-	-0.92 ***	-0.91 ***
E2	-	-	0.91 ***

Table 2. Sugar beets

Site of origin		PI	E_2	DI
1	hypocot	94	81.4	18.2
	root 1	11	85.6	58.3
	root 2	43	83.4	64.4
	root 3	37	89.0	82.0
2	hypocot	78	84.7	21.7
	root 1	50	83.0	52.8
	root 2	33	82.6	71.7
	root 3	27	86.6	89.0
3	hypocot	72	80.8	31.1
	root 1	33	85.4	61.8
	root 2	17	91.4	84.9
	root 3	19	92.7	96.0
Layer	hypocot	81	82.3	23.7
	root 1	31	84.7	57.6
	root 2	31	85.8	73.7
	root 3	28	89.4	89.0
Correlation				
PI		-	0.71 +++	0.79 +++
E_2		-	-	0.77 +++

Explanations: 1 - hypocotyl, root 1 = first third part of the root.

Table 3. Apples

Cultivar	PI	E_2	DI
Auralia	83	69.2	43.4
Boskop	71	68.7	58.9
Gelb. Köst.	66	72.1	48.8
Cox	50	68.8	50.0
Gloster	96	70.2	47.5
Pfannk.	71	63.3	44.2
Carola	41	79.2	76.3
Correlation			
PI	-	0.55 ++	0.58 ++
E2	-	-	0.75 +++

The Pendulum allows also a determination of bruise susceptibility of sugar beets and apples, but the methods of work with the pendulum for these objects have to become more addaptable in additional tests.

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