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Measurement of the water absorption rate in wheat grain

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A b s t r a c t. The paper presents measurements of the rate of water absorption in wheat grain by the capillary – weight method. Measurements were taken for three grain fractions which took water with the characteristic parts, i.e.: groove, germ etc.

K e y w o r d s: water absorption, wheat grain, capillary-weight method

INTRODUCTION

Water present in plant materials can be bound chemically and by adsorption or remain in the unbound state [1,2,7, 9,10]. Change in the moisture level results in changes of the physical properties of plant material [8]. Water absorption rate in seeds is influenced by many factors such as: the structure of seed cover (level of permeability), size and phase of maturity of seeds, their size (fractions) and their chemical composition [3,4,11-14].

It is also known that various parts of grain take water at different rates (e.g., a germ). Water absorption rate is also dependent on grain size.

MATERIAL AND METHODS

This paper presents the results of the measurement of the water absorption rate by wheat grain using a modified capillary-weighting method. The tests were aimed at the measurement of three different fractions, for three different ways of putting grains on a wet tissue, by the capillary-weighting method [5,6]. Measurements were taken for grains of the spring wheat variety Henika with an initial moisture 10.1%. Tests were made on grains of fractions: 2.0, 2.5, 3.1 mm. The selection was carried out by means of Fogel sieves, manufactured by Workshop Institute of Agriculture. The mass of a thousand grains of fraction 2.0 was equal to: $m_{2.0/1000} = 20.923$ g, $m_{2.5/1000} = 32.975$ g, $m_{3.1/1000} = 50.435$ g.

Wheat grains were put with their grooves facing downwards on a tissue fixed to a metal ring and placed in a special form with holes of adequate diameter, with their germs facing either downwards or upwards (Fig. 1).

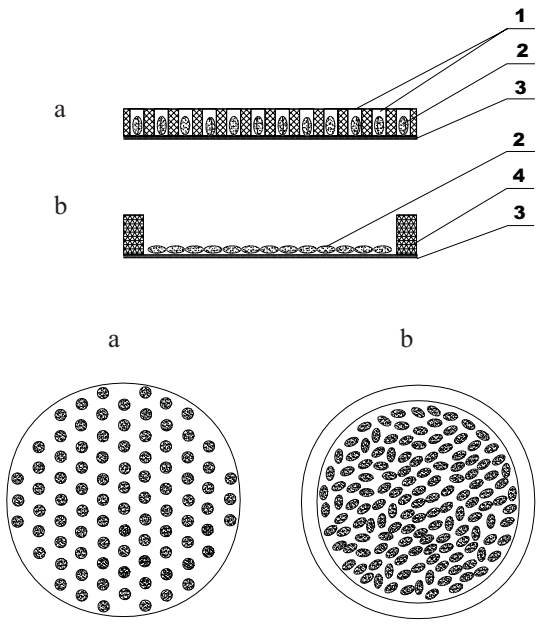

Fig. 1. Forms for grains: in the shape of a plate with holes for grains with their germs facing downwards and upwards (a), ring-like form for grains with their grooves facing downwards (b): 1 – wheat grains, 2 – metal ring, 3 – tissue, 4 – holes with diameters adequate for a particular grain fraction.

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Such forms with grains were placed on a wet tissue in a unit for the measurement of water absorption rate by the capillary - weighting method. The rate of water absorption according to the different positions of the grain of the three sizes fractions was determined at 21°C in three repetitions for 184 grains singly.

The water absorption rate was measured on a special measurement unit presented graphically in Fig. 2. The unit consists of a pair of electronic scales WPS 360/C precise to 1 mg, connected to a computer collecting the data by means of WAGAWIN (software by RADWAG).

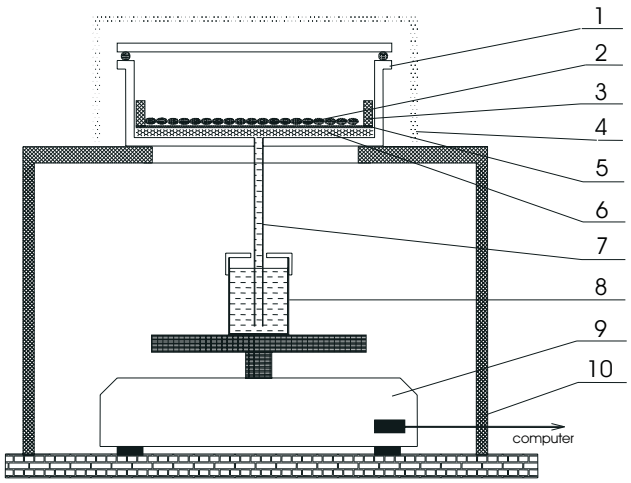

Fig. 2. Draft of the measurement unit: 1 – thermostatic container for grains, 2 – grains, 3 – ring, 4 – thermostatics (cover), 5 – tissue fixed to the ring, 6 – wet tissue, 7 – capillary, 8 – water container, 9 – electronic scales, 10 – support base for the container.

The grains were placed in a hermetic, thermostatic container on a wet tissue. The tissue, placed at the bottom of container, adhered precisely to a glass capillary with an inner diameter φ = 1.5 mm, stuck to the bottom of the container. The tissue was watered after introducing the end of the capillary to a small container with distilled water, placed in a container located in one pan on scales. Excess water dripped into the tube until a steady level of the tissue's wetness was achieved. At that point the measurement was begun by placing a grain sample on the tissue and closing the container hermetically.

The increase of water content in the sample at the measurement k for a given time period t expressed as a percentage, was calculated from the formula:

$$N_K = \frac{(m_{PW} - m_{KW}) - m_{PAR}}{m_{PZ}} 100\%$$

where: m_{PW} – the initial mass of water in the container at the beginning of measuring (g), m_{KW} – the mass of water in the container at measurement k (g), m_{PZ} – the initial mass of the grain at the beginning of measurement (g), m_{PAR} – the stable mass of water evaporated from the water container (8) through the ring-like hole in the lid (g), experimental appointed for a given constant temperature at empty (without grains) main reservoir.

RESULTS

The results are presented in the form of point charts and Table 1. Figures 3-5 show the characteristics of the water absorption rate for three different ways of placing wheat grains of different fractions on a wet tissue. The characteristics of the water absorption rate for the three size fractions tested but for different positions of the grains are presented in Figs 6-8.

The results presented suggest that the fastest rate of water absorption is shown by smaller grains irrespective of their

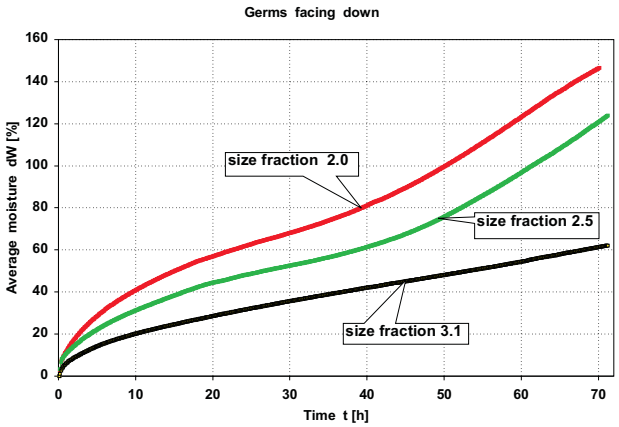

Fig. 3. Water intake rate in wheat grain of three size fractions, grain germs face down.

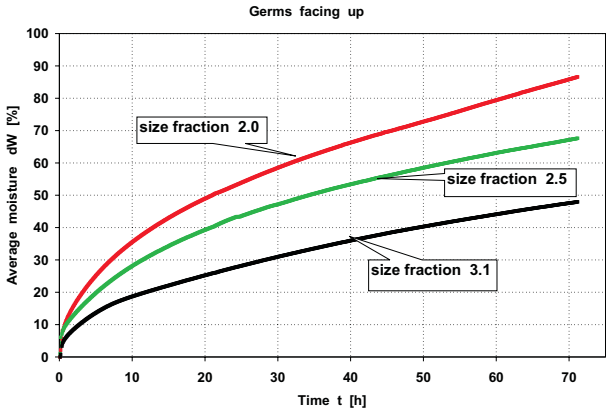

Fig. 4. Water intake rate in wheat grain of three size fractions, the germs of the grains facing up.

positions (Figs 3-5). The fastest water absorption is shown in small grains (fractions 2.0 and 2.5) placed with their germs facing down (Figs 6, 7). However, there are no significant differences in water absorption rate in grains with the fraction 3.1 for the three different positions of grains (Fig. 8).

Errors made during measuring were determined as a standard deviation of an arithmetical mean, for three measurement points. The error scale ranged from 0.25 to 1.55% for particular measurement points on the point charts of the water absorption rate.

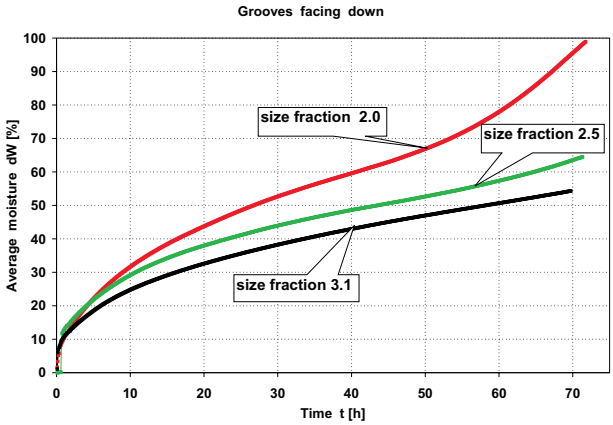

Fig. 5. Water intake rate in wheat grain of three size fractions, the grooves of the grains facing down.

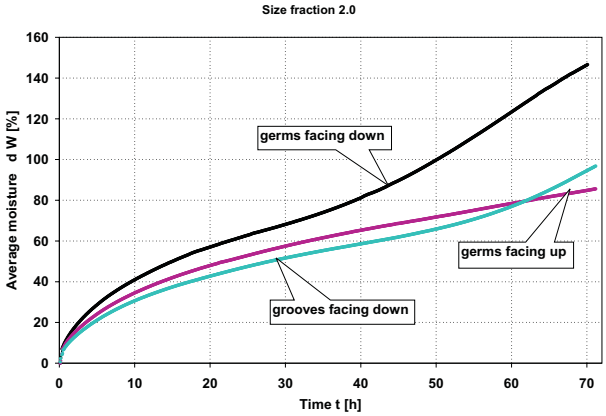

Fig. 6. Water intake rate in the wheat grain size fraction 2.0 for three kinds of placement on wet tissue.

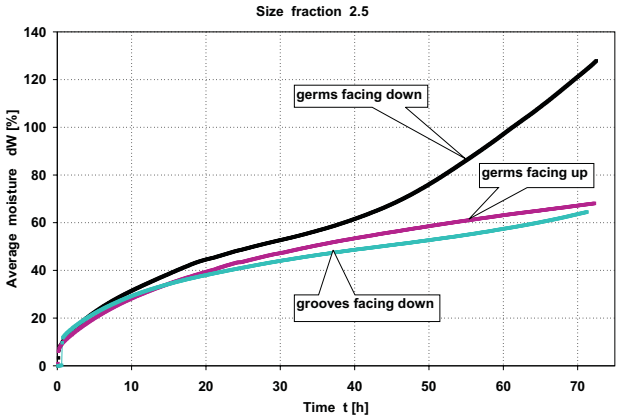

Fig. 7. Water intake rate in the wheat grain size fraction 2.5 for three kinds of placement on wet tissue.

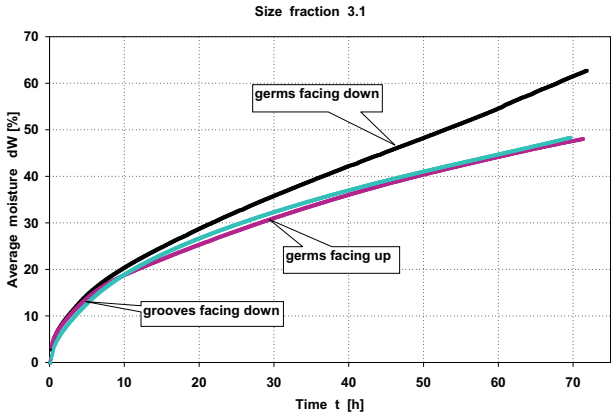

Fig. 8. Water intake rate in the wheat grain size fraction 3.1 for three kinds of placement on wet tissue.

T a b l e 1. Percentage water intake rate in the three fraction sizes of wheat grain for three kinds of placement on wet tissue for 40th hours time water absorption

Size fraction (mm)	Germs facing down	Germs facing up	Grooves facing down
2.0	81.19	66.28	59.59
2.5	61.47	53.39	48.63
3.1	42.15	35.99	42.95

CONCLUSIONS

1. Measurements of the water absorption rate in wheat grain by the capillary-weighting method permit the investigation of this process in grains of different fractions, for the three characteristic ways of their positions on a wet tissue, over a long period of time.

2. The measurements confirm the greatest speed of receiving waters in small grains and that the greatest increase in the content of water in grains takes place in their germs.

3. On the basis of investigation, it can be confirmed that using the capillary-weighting modification method is efficient and makes it possible to measure the speed at which waters are received by the different parts of grains with great accuracy.

4. The investigations carried out show that this method of water absorption rate measurement can be used for other kinds of cereal grain.

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