Savremena poljoprivredna tehnika
Cont. Agr. Engng. Vol. 41, No. 1, 1-66, mart 2015.

Biblid: **0350-2953 (2015) 41(1): 1-8** Originalni naučni rad
UDK: **631.563:633.15** Original scientific paper

THE EFFECT OF CONDITIONS AND STORAGE TIME ON COURSE OF MOISTURE AND TEMPERATURE OF MAIZE GRAINS
EFEKTI USLOVA I VREMENA ČUVANJA NA TOK VLAGE I TEMPERATURE ZRNA KUKURUZA

Angelovič Marek, Jobbágy Ján, Findura Pavol, Fiantoková Soňa

Faculty of Engineering, Slovak University of Agriculture,
949 76 Nitra, Tr. A. Hlinku 2, Slovakia
e-mail: marek.angelovic@uniag.sk

ABSTRACT

Characteristics of stored cereals significantly affect the technical solution of individual storage facilities, as well as the technical appliances used to provide storage Technologies, i.e. storing aeration and off-loading. The objective of the work was to monitor the influence of atmospheric temperature and extraneous moisture on the course of temperature and moisture of maize grain during the storage. Monitoring of parameters was initiated in October, after the maize was stored to steel silo chambers and to the floored warehouse until the off-loading in August of the following year.

Keywords: maize grains, grain storage, steel silos, floored warehouse.

1. INTRODUCTION

Field grain harvesting is followed by post-harvest treatment, which is essential for storage. During the post-harvest treatment, grain is cleaned from substantial part of impurities and grain is dried to the moisture of 14 to 14.5 % of its weight, if necessary. The purpose of the storage is to preserve and improve the grain quality. Technological properties can be improved by proper storage. Warehouses should be steady enough to protect grain against weight reduction, caused by atmospheric conditions and animal pests. We cannot avoid grain weight reduction during the storage, which is caused by respiration, diffusion and mechanical damage (Doležal et. al., 2004).

Temperature and moisture are basic indicators affecting the realization of successful long-term cereals storage. The temperature of the stored grain is an important parameter, which is influenced by the oxygen availability. Grain storage in closed areas causes a formation of carbon dioxide and oxygen reduction, because of permanent respiration. Therefore, respiration intensity of grain is reduced gradually. Aeration should provide air supply with low air moisture; even the air temperature should be at least by 5 °C lower compared to the temperature of ventilated grain. Hygroscopicity, an ability to absorb and to exclude water vapor, has a significant impact on the grain quality and the storage ability. Grain water content differs with the change of air moisture and

temperature. Reduction of grain water content is most frequently realized by residual drying (moisture is less than 15 %); the storage stability is provided at the moisture of 12 % (Jech et. al., 2002).

2. MATERIALS AND METHODS

Characteristics of grain warehouse

Currently, most frequently used grain warehouses are steel silos (Fig. 1). They are high buildings with shaft chambers, which are called silo cells, with circular or hexagonal shape of floor projection. They are use to store only dry grain with the moisture content up to 14 %. Silo cells are made of ferroconcrete or metal. These height containers have different air distributions used for ventilation and aeration of stored grain in relation to the type and structure.

Hangar-type warehouse are generally used for grain storage at post-harvest lines, for seed storage, as well as for temporal storage of damaged stock (Fig. 2). They are formed by a closed external roofed building structure. These buildings have quite complicated built-in ventilation system, which enables complete drying and aeration of stored grain (Skalický et. al., 2008).

Figure 1. Steel silos

Figure 2. Floored warehouse

Monitoring of the effect of storage conditions on product quality

Characteristics of stored cereals significantly affect the technical solution of individual storage facilities, as well as the technical appliances used to provide storage technologies, i.e. storing, aeration and off-loading.

Complicated chemical processes occur during cereal storage. These can ultimately cause the loss of nutritional value. Part of the loss is caused by a natural reaction (breathing kernels); another part of the loss is caused by chemical reactions that are a result of the violence of technological discipline at post-harvest treatment and storage of cereals (Mareček, Frančáková, 2011).

Main characteristics of the grain in relation to grain storage are:

- grain volume weight and void fraction,
- pourability of cereals,
- temperature of cereals,
- balanced water content of cereals,
- unfavourable impurities content.

We monitored:

- the effect of crop temperature at the beginning of storage on ventilation frequency,
- the effect of grain moisture on storage period,
- occurring of animal pests in relation on the ambient temperature and the storage period.

Machines, devices and instruments

We used machines, devices and equipment on the agricultural farm AgroDivízia, Ltd. in Selice for our experimental measurements. We used specialized devices and instruments belonging to the laboratory equipment for agro-physical characteristics detection, i.e. hygrometer, thermometers, digital scales, measuring device for volume weight etc.

Experiment evaluation methods

We used verified statistical calculation procedures for measured values evaluation. We used Microsoft Excel software for graphical processing and mathematical-statistical results evaluation.

3. RESULTS AND DISCUSSION

Technology and methods of storage affect the temperature and moisture of the material, which could have an impact on the storage period and ton animal pests evolution.

We realized our experimental measurements of maize grain storage at steel silos and floored warehouses considering equipment opportunities of farm AgroDivízia, Ltd. in Selice.

Monitoring of parameters of moisture and temperature of maize grain stored in steel silos

Measured values of temperature and moisture of maize grain stored in monitored steel silo are represented graphically in Figure 3.

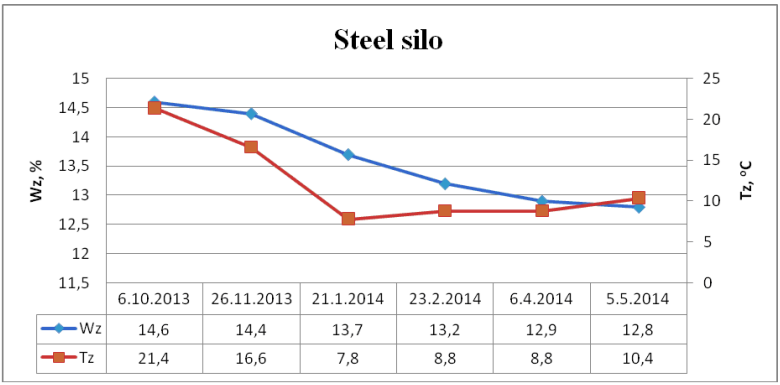

Figure 3. Progress of moisture and temperature of maize grain stored in steel silo in dependance on storage period:
W_z - moisture of maize grain ,T_z - temperature of maize grain

From the measured values we can state, that an average value of maize grain moisture is 13.6 % within the timeframe, with the maximum value of 14.6 % and minimal value of 12.8 %. We can state, that that an average value of temperature inside of the silo is 12.3 °C within the timeframe, with the maximum value of 21.4 °C and minimal value of 7.8 °C. The moisture of stored grain correlates positively with storage temperature of the grain.

Simultaneously, with the measurement realized inside of the steel silo, we monitored external conditions during the storage, i.e. air moisture and temperature, which have a significant impact on storage conditions.

Measured values of atmospheric temperature and extraneous moisture in the area of monitored steel silo are represented graphically in Figure 4.

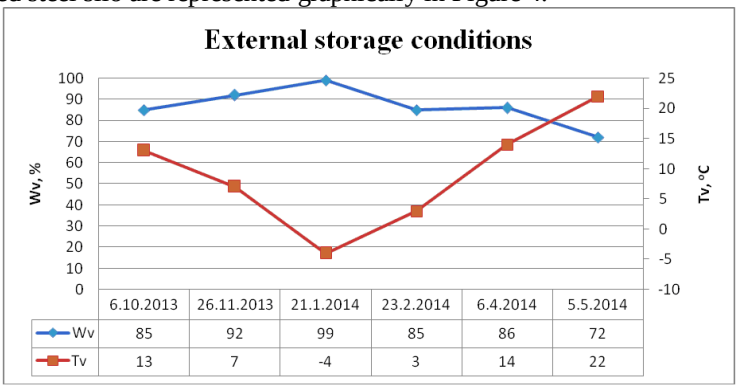

Figure 4. Progress of air moisture and temperature during the storage in the area of monitored steel silo in dependance on storage period:

W_v - air moisture, T_v – air temperature

From the measured values we can state, that an average value of air moisture is 86.5%, within the timeframe, with the maximum value of 99 %, and minimal value of 72 %. We can state, that that an average value of air temperature in the area of silo was 9.17 °C within the timeframe, with the maximum value of 22 °C and minimal value of - 4 °C. Similarly, air moisture correlates with air temperature. A reduction of atmospheric temperature is increasing extraneous moisture, resulting in a direct impact on the course of moisture and temperature of stored maize grain in steel silo (Figure 3).

Monitoring of parameters of moisture and temperature of maize grain stored in floored warehouse

Measured values of temperature and moisture of maize grain stored in monitored floored warehouse are represented graphically in Figure 5.

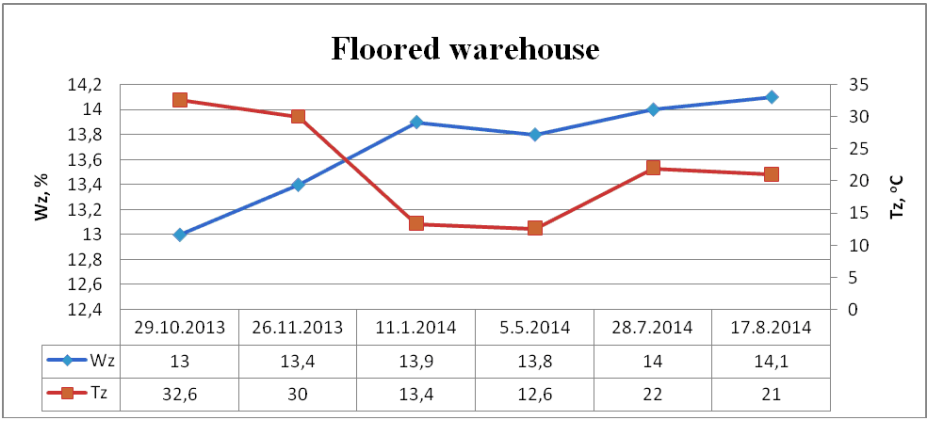

Figure 5. Progress of moisture and temperature of maize grain stored in floored warehouse in dependance on storage period :
W_z - moisture of maize grain ,T_z - temperature of maize grain

From the measured values, we can state that, that an average value of maize grain moisture is 13.7 % within the timeframe, with the maximum value of 14.1 % and minimal value of 13 %. We can state, that that an average value of temperature inside of the floored warehouse is 21.9 °C within the timeframe, with the maximum value of 32.6 °C and minimal value of 12.6 °C. The moisture of stored grain correlates with storage temperature of the grain, but with different course than in the steel silo.

Simultaneously, with the measurement realized inside of the floored warehouse, we monitored external conditions during the storage, i.e. air moisture and temperature, which have a significant impact on storage conditions.

Measured values of atmospheric temperature and extraneous moisture in the area of monitored floored warehouse are represented graphically in Figure 6.

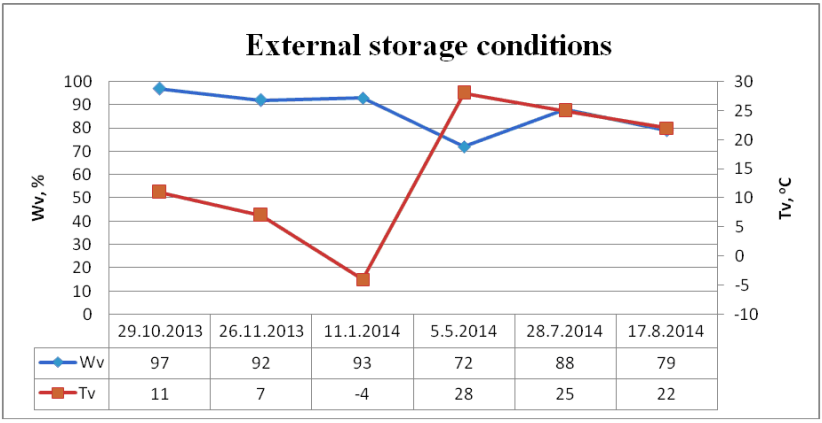

Figure 6. Progress of air moisture and temperature during the storage in the area of monitored floored warehouse in dependance on storage period : W_v - air moisture, T_v – air temperature

From the measured values we can state, that an average value of air moisture is 86.8 % within the timeframe, with the maximum value of 97 %, and minimal value of 72 %. We can state, that that an average value of air temperature in the area of warehouse is 14.8 °C, with a maximum value of 28 °C and minimal value of - 4 °C. Similarly, air moisture correlates with air temperature. A reduction of atmospheric temperature is increasing extraneous moisture, resulting in a direct impact on the course of moisture and temperature of stored maize grain in floored warehouse (Figure 5).

4. CONCLUSIONS

Based on experimental measured results and their evaluation can be stated, that extraneous conditions during the storage, i.e. atmospheric temperature and extraneous moisture have a significant impact on the conditions of maize grain storage.
Considering conditions, better results were observed for steel silo storage with a possibility of extra-ventilation stored layers. An average value of maize grain moisture was 13.6 % and an average value of temperature inside of the silo was 12.3 °C within a defined timeframe.

An average moisture value of maize grain stored in the floored warehouse was 13.7 %, but an average temperature inside the warehouse was 21.9 °C, however extraneous conditions during the storage were unchanged. Average value of extraneous moisture was 86.5 % and an average value of atmospheric temperature was 9.17 °C.

We did not record any occurrence of animal pests in stored maize grain during the storage.

Grain water content differs with the change of air moisture and temperature. Reduction of grain water content is most frequently realized by residual drying (moisture is less than 15 %); the storage stability is provided at the moisture of 12 %.

The topic of the cereals storage in relation to machines, technological and economical point of view poorly understood in the Slovak Republic, hence this topic will be the subject of further research by the Department of Machinery and Production Systems, Faculty of Engineering, SUA.

REFERENCES

[1] Doležal P. et. al. 2004. Skladování a konzervování krmív. In. *Krmovinářství*, č. 4. Brno: MZLU, 2004, s. 28 – 31.

[2] Jech, J. et al. 2002. Výskum vplyvu technických a technologických podmienok na účinnosť liniek pozberovej úpravy obilnín. In *Záverečná správa čiastkovej úlohy 01-VTP.č. 27-23, KSVS*. Nitra: SPU, 2002, 140 s.

[3] Mareček, J. – Frančáková, H. 2011. Vplyv veľkokapacitného skladovania na kvalitu vybraných odrôd sladovníckeho jačmeňa. In *Bezpečnosť a kontrola potravín (Zborník prác z VIII. medzinárodnej vedeckej konferencie, Nitra 30. – 31. marec 2011).* Nitra: SPU, 2011, s. 250 – 252. ISBN 978-80-552-0559-5.

[4] Skalický J. a kol. 2008. *Ošetřování a skladování zrnin ve věžových zásobnících a halových skladech (Metodická příručka MZe ČR).* Praha: Výzkumný ústav zemědělské techniky, 2008.

Acknowledgements: The research leading to these results has received funding from the European Community under project no 26220220180: Building of Research Centre „AgroBioTech".

EFEKTI USLOVA I VREMENA ČUVANJA NA TOK VLAGE I TEMPERATURE ZRNA KUKURUZA

Angelovič Marek, Jobbágy Ján, Findura Pavol, Fiantoková Soňa

Faculty of Engineering, Slovak University of Agriculture,
949 76 Nitra, Tr. A. Hlinku 2, Slovakia
e-mail: marek.angelovic@uniag.sk

ABSTRAKT

Karakteristike uskladištenih žitarica značajno utiču na tehničko rešenje pojedinih skladišta, kao i tehničke uređaje koji se koriste da obezbede uslovi čuvanja. Kao što su čuvanje provetravane i istovar. Cilj rada je bio da se prati uticaj okolna temperatura i sadržaj vlage okolnog vazduha na tok temperature i vlažnosti zrna kukuruza tokom skladištenja. Pokrenut je monitoring parametara u oktobru, nakon što je kukuruz bio uskladišten u silosu od čeličnog lima i do čuvao do istovara u avgustu naredne godine.

Ključne reči: kukuruz, skladištenje žitarica, čelični silosi, skladišta.

Primljeno: 18. 02. 2015. god. **Prihvaćeno**: 30. 02. 2015. god.