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# TEMPERATURE VARIATIONS IN A METAL BIN DURING ON FARM BULK STORAGE OF PADDY (*Oryza sativa)*

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**Abstract:** The study was carried out on the temperature variations inside a metal bin of capacity 5.3 tones under a typical tropical weather conditions in Thanjavur, Tamil Nadu. Temperature variations inside and outside the bin were monitored from August (2016) to April (2017) during storage of paddy. Temperature of paddy at various locations inside the bin was recorded every hour. Results showed that the fluctuations in temperatures were 3.47°C and 6.22°C for the ambient and metal bin respectively. Among the different layers of metal bin the highest temperatures (36.96°C) were found at the top layer and the lowest at the bottom layer (29.62°C) during the storage period. The grain temperatures at the centre of the bin ranged between 31.78°C and 38.08°C. This study indicated that storage temperature variations and ambient temperature had a key role during storage in metal bins to decide safe storage time.
**Keywords:** Temperature, Paddy, Tropics, Bin, Storage time.

## INTRODUCTION

A stored grain bulk is a manmade ecological system in which deterioration of the stored product results from interactions among physical, chemical and biological factors. Temperature is a major factor considered in the safe storage of grains. When an appreciable temperature gradient exists within bulk grains, it causes mold growth due to moisture migration (J.T. Mills, 1989). A major factor influencing grain deterioration during storage is temperature because grains are biologically active, giving off heat during respiration (Geoffrey at al., 2011).

Silos remain the most suitable structure for bulk grain storage and their performance is greatly influenced by the engineering properties of the construction material and the climatic environment where they are used (B.A. Alabadan, 2006).

Grains in India, is stored at farmers, traders and industrial levels. Sawant et al., (1994) described the modern grain storage methods such as Godown storage and silo systems for reducing storage losses. He compared Godown storage and silo storage with respect to functional, structural and financial aspects, which revealed the superiority of silo system. Up

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to date, very few data is available on temperature changes in grain bulks stored under tropical conditions. These few data concentrated on comparative tests of temperature variation within silos of different materials using empty silos (Lucas et al., 1996; Sinha R.N, 1973).Temperature in storage is one of the most important factors that determine grain storage quality (Muir, 1980; Brooker et al., 1992). There are no much published data available showing the temperature variations inside metal bins during storage of paddy.

The objective of this work is to study the temperature variations in metal bin of 5.3 tones capacity made of galvanized iron(GI) during storage of paddy (*Oryza sativa*) under tropical conditions.

## MATERIALS AND METHODS

### Storage bin

The experiment was conducted in 5.3 tones capacity Galvanized Iron (GI) bin (Make: Fowler & Westrup, Bangalore) (Fig. 1) located at Indian Institute of Food Processing Technology, Thanjavur, Tamil Nadu. The metal bin is provided with internal reinforcement rings which prevent the deformation during heavy winds. The flat bottom bin was 1.9 m in diameter, 3.87m in height which includes 0.44m from top of the cylinder to the peak of the conical roof, 3.43 m cylindrical part, and 2.5m concrete foundation above the ground. The conical roof had a 0.4m diameter vent at the peak and it was closed during the experimental studies.

The paddy was procured from the farmers of Thanjavur district after harvest. The paddy was cleaned and dried to safe moisture level. The GI bin was filled with paddy on 2$^{nd}$ August 2016. The initial moisture content of paddy was 11.2 percent (wet basis). The storage study was conducted till 30$^{th}$ April 2017.

### Temperature measurement

Temperatures inside the storage bin were recorded every hour at 20 locations during the complete storage period including central axis. *k-type* thermocouples with an accuracy of $\pm$0.5°C and temperature range of -200$^{o}$ C to 350$^{o}$ C were used to measure the temperatures. The thermocouples were mounted on plastic ropes which were anchored on the floor and ceiling of the bin. The storage bin was divided in to four layers i.e., Top, top lower (TL), bottom upper (BU) and bottom of the bin and 5 thermocouples were fixed in each layer including centre axis to monitor the temperature variations inside the bin during storage period. The thermocouples were connected to a data logger model Data taker DL2e (Make: Delta T devices Ltd., United Kingdom).


Fig. 1 Galvanized Iron bin

## RESULTS AND DISCUSSION

### Temperature variations at ambient and inside the metal bin

The changes in the ambient temperatures caused the differences in the mean temperature in the paddy bulk stored in metal bin during the storage period from August (2016) to April (2017) were recorded and the results are depicted in Fig.2. From the figure it was found that the maximum mean temperature recorded for the ambient and metal bin was 33.35°C and 36.82°C respectively. The minimum mean temperature for the ambient and metal bin was 25.84°C and 32.06°C respectively. This resulted into fluctuations of 3.47°C and 6.22°C for the ambient and metal bin respectively. For the first two months the temperature difference between ambient and inside the bin was minimal. This difference gradually increased from October to March when monthly average temperatures inside the bin were higher than the ambient.

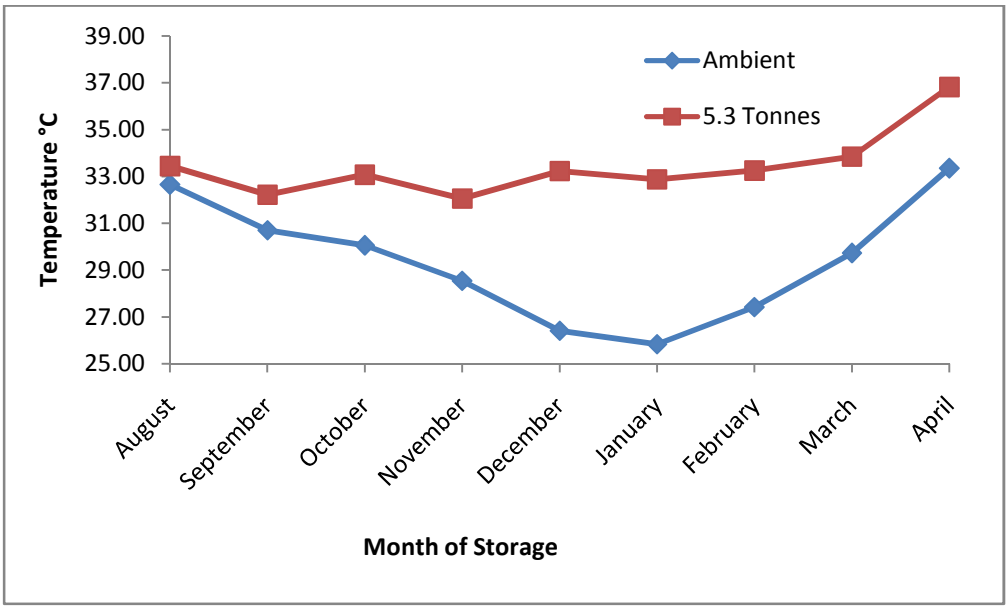


Fig. 2 Mean temperature variations inside the bin

**Temperature variations at different layers of metal bin**

Temperatures measured at different layers i.e., Top, top lower (TL), bottom upper (BU) and bottom of metal bin are given in Fig.3. Grain temperatures were mainly influenced by seasonal weather temperatures. From the fig. it was observed that the top layer of grain was influenced by solar radiation and ambient temperature. Among the different layers of paddy the highest temperatures were found at the top layer and the lowest at the bottom layer. During the storage period the highest temperature was found in the month of April (36.96°C) due to high temperatures prevalent during the dry season of April and minimum temperature was observed in the month of January (29.62°C) due to low temperatures during the cool weather outside. The same temperature variations were noticed by Chelladurai et al. during storage of canola in silo bags. The contour plot for the temperature variations in paddy at different layers of bin is shown in Fig.4.

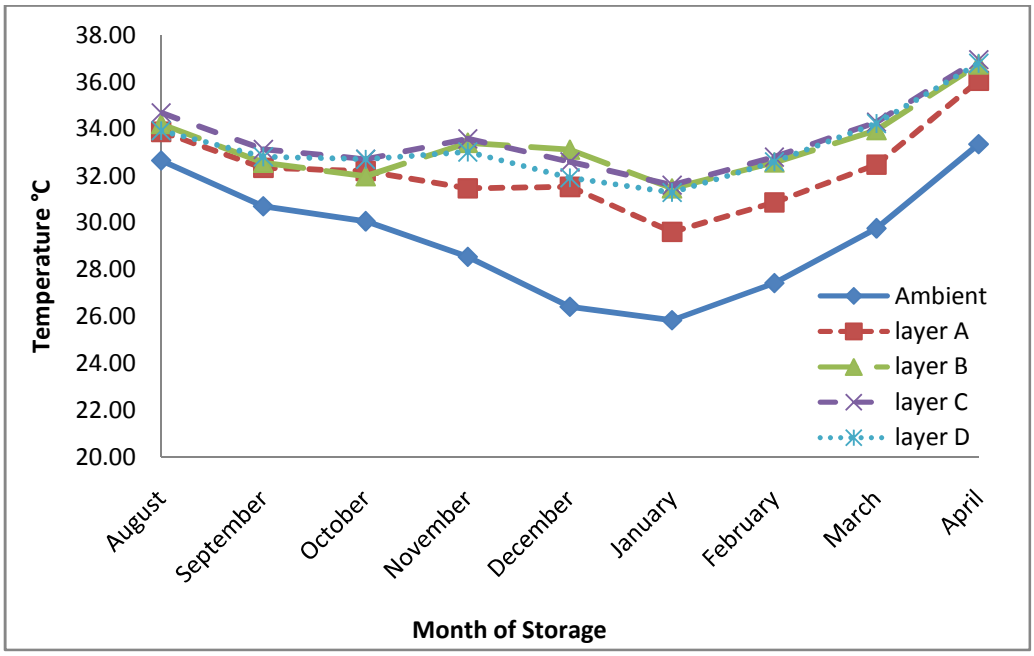


Fig.3. Temperature variations at different layers of the bin

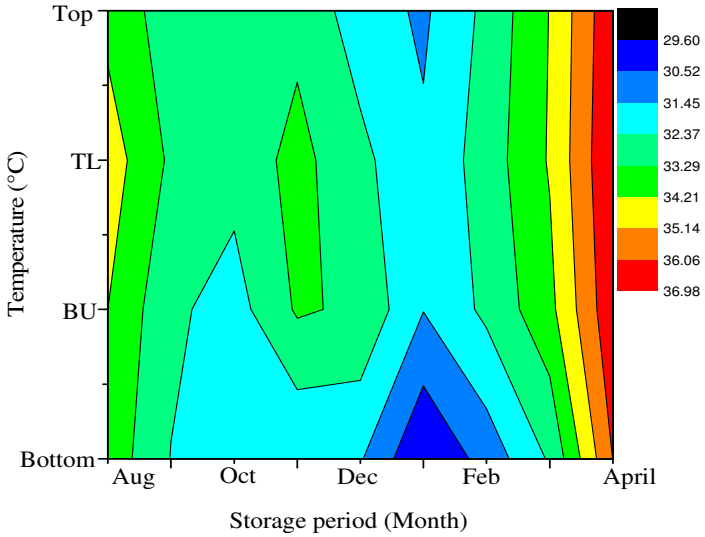


Fig.4 Contour plots for the temperature variations in paddy at different layers of the bin

**Temperature variations at the centre of metal bin**

The temperature of the paddy at the centre of the bin is presented in Fig. The temperature is generally higher than the other parts of the bin. The minimum and maximum temperatures at the central axis of bin are 31.78°C and 38.08°C respectively. This shows that the large temperature gradient which may be responsible for moisture migration.

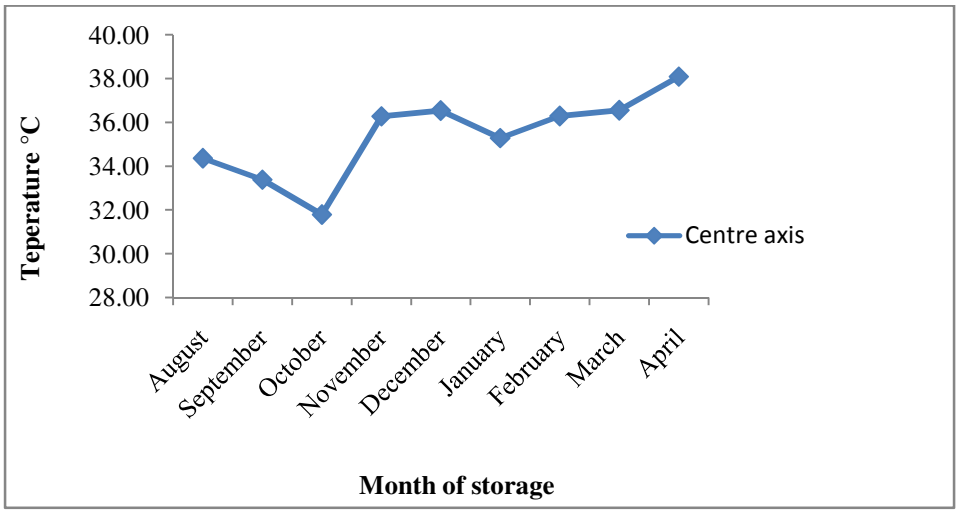


Fig. 5 Temperature variations at the centre axis of the bin

## Conclusion

There was larger temperature fluctuation in the central axis of bin than the other areas inside the bin. Temperatures were higher at the end of the storage period than the beginning due to change in weather conditions. Aeration or unloading and loading may be the solution to control the increase in temperature to maintain the quality of grain. This implies that storage temperature variations had a significant role during storage in metal bins to decide safe storage time.

## References

[1] B.A. Alabadan (2006): Evaluation of Wooden Silo during Storage of Maize (Zea mays) in Humid Tropical Climate; Agricultural Engineering International; the CIGR Ejournal, Manuscript BC 05 013, Vol VIII.

[2] Brooker, D.B., Bakker-Arkema, F.W., Hall, C.W., 1992. Drying and Storage of Grains and Oilseeds. Van Nostrand Reinhold, New York, NR, USA. Chang, C.S., Converse,

[3] C.M. Geoffrey, L.O. Gumbe, H.J. Chepete and J.O. Agullo (2011): Rural structures in the tropics. Design and development. CTA Postbus 380, 6700 AJ Wageningen, The Netherlands; www.cta.int.

[4] J.T. Mills (1989): Spoilage and heating of stored agricultural products: prevention, detection and control. (Publication: 1823E) Includes Index. Bibliography: SB129.M54 1988 631.5’68 C88099204-2.

[5] Lucas E.B., Mijinyawa Y. (1996), *Comparative Studies of Temperature Fluctuations within Wooden and Steel Silos Erected in Ibadan*, Proceedings of the 18th Annual

Conference of the Nigerian Society of Agricultural Engineers, O.A.U., IleIfe.,1996, p. 299302.

[6] Muir, W.E., Fraser, B.M., Sinha, R.N., 1980. Simulation model of two dimension heat transfer in controlled- atmosphere grain bins. In: Shejbal, J. (Ed.), Controlled Atmosphere Storage of Grain. Elsevier, Amsterdam, pp. 385-397.

[7] Sinha R.N. (1973), *Interrelations of Physical, Chemical and Biological Variables in the Deterioration of Stored Grains*, In: *Grain Storage: Part of a System*, Edited by Sinha R.N., and Muir W.E., AVI Publishing Company, New York, 1973, p. 1548.

[8] Sawant, S.D. 1994. Modern grain storage for reducing storage losses. Agricultural Engineering Today, (1) 4: 12-20.

[9] V. Chelladurai et al., 2016. Quality changes in 12% moisture content canola stored in silo bags under Canadian Prairie conditions. Journal of Stored Products Research 68, 33-43.