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Effect of temperature, relative humidity and moisture changes on germination percentage of paddy stored in GIC silo in Konkan region of Maharashtra

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Abstract **:** The research paper presents the information regarding the pattern of changes in the environmental conditions *i.e.* temperature, relative humidity and moisture content on the stored paddy in Galvanized Iron Corrugated (GIC) silo. The grain moisture in the silo decreased from 13.9 per cent to 12.1 per cent during the storage period July to January. The moisture content of the grain increased from 12.3 per cent to 13.9 per cent during storage month of May to July. The temperature inside the silo was 29.3 ^{0}C to 26.4 ^{0}C than ambient temperature of 31.2 ^{0}C to 28.9 ^{0}C during storage month of April to January. The relative humidity inside the silo varied from 69.8 per cent to 71.7 per cent with storage period April to January. The germination percentage of grain inside the silo was decreased from 70.6 per cent to 52.3 per cent during storage period of April to January.

Key words **:** Temperature, Moisture content, Relative humidity, Germination percentage, Paddy, GIC, Silo

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Paddy (*Oryza sativa*) is the most important and extensively grown food crop in the world. It is the staple food of more than 60 per cent of the world population. Rice is mainly produced and consumed in the Asian region. India has largest area under paddy in the world and ranks second in the production after China.

The Konkan region of Maharashtra State is located at 17^{0}45'32" N latitude and 73^0 11'8" E longitude with an altitude of 250m above mean sea level (msl). The paddy is main food crop growing in this region. The region has a hilly terrain and receives an average annual rainfall ranging between 3000 to 4000 mm. Relative humidity lies between 55 per cent to 100 per cent. The temperature ranges between 25^{0}C to 35^{0}C. The climate of this region is hot and humid. At this condition the stored grains are damaged. Therefore it is necessary to provide solution for safe storage of paddy using modern storage techniques on commercial basis.

Primary aim of storage is simply to prevent deterioration of quality of grain. This is done indirectly through control of moisture and air movements and by preventing attack of microorganisms, insects and rodents. Farmers throughout the world, in every country at hot or cold climate store grain. They may store in traditional storages like earthen pots, in pits or in a granary, modern storages either in bulk or in reasonably sophisticated storages. They store some large quantity of the grains.

The most important physical factor in grain storage is moisture content because it affects the growth of mould, with which all stored grains are infected. It is generally accepted that climatic conditions are lead to physical changes in stored bulk grain through the movement of moisture which leads to deterioration. This study was implemented to investigate the changes in the temperature, RH and moisture content in freshly harvested bulk paddy during a storage period of ten months (April 2009 to January 2010). The study was carried out at the Department of Agricultural Process Engineering, CAET, Dapoli. The paddy was stored in Galvanized Iron Corrugated (GIC) silo having capacity of 1.25 tonne, which is shown in Fig. A.

Singh *et al.* (1981) studied the effects of methods and duration of storage on seed germination and seedling vigour in papaya (*Carica papaya* L.). It was found that cold stored papaya seeds maintained significantly higher germination and better seedling vigour than the room stored seeds. With the increase in the duration of storage, seed germination decreased after 20 months at room temperature whereas it declined marginally during the same period when kept in the cold storage. Irrespective of the storage conditions, seeds kept in

Fig. A : Galvanized Iron Corrugated structure for storage of paddy

sealed polythene bags or plastic bottles had better germination and seedling vigour than paper and cloth bags.

Gough (1985) studied the physical changes in large- scale hermetic grain storage. Moisture content and temperatures were measured in two 1300t semi-underground hermetic concrete silos filled with maize, which was stored for nearly three years in an upland equatorial climate. Gradual cooling of the maize took place in the first year of storage and the temperature remained constant thereafter. Siebenmorgen *et al.* (1989) described a storage technique in which grain is piled on large, flat surfaces and covered with an airtight liner. Temperature and relative humidity data collected while monitoring a field scale unit equipped with an aeration system. The results of the monitoring study indicated that the bunker storage system with aeration system used could effectively cool the grain mass to a typically safe storage temperature of 10^0C.

Rondon *et al.* (2000) studied the effects of moisture content and temperature during storage on germination of the achenes of *Bidens garddneri*. *Bidens gardnery* is a herbaceous species of the cerrados, whose seeds are light sensitive at 25^0C, but they become indifferent to light when stored in soil. Achenes were stored in darkness or light, in closed bottles, at 4^0C and 25^0C. It was found that the achenes not previously imbibed showed sensitivity to light during germination. Dejene *et al.* (2004) studied the impact of grain storage methods on storage environment and sorghum grain quality. The experiment was conducted at Hararghe, Ethiopia. The farmers stored their sorghum grain in underground pits during a period of 24 months. Temperature and moisture content were higher in the soil pit than in the bin, cement and dung pits. The bin maintained the lowest temperature and grain moisture content. Bulk density of sample from the soil pit decreased by 9 per cent while the changes in other three stores was not significant. Regression analysis of percentage germination on grain storage period showed that germination of samples from soil pit decreased by 6 per cent per storage month.

Thilakarathna *et al.* (2006) studied quality change and mass loss of paddy during airtight storage in a Ferro-cement bin in Sri Lanka. An airtight storage system, based on a Ferro-cement bin, was developed. The objective of this study was to evaluate the storage system in terms of paddy quality and mass loss. Samples were drawn before and after storage from this bin and a control, to analyze moisture content, thousand-grain mass, insect infestation, mould, germination rate and head rice yield. Germination rate, however, decreased from 85 per cent to 0 per cent in the airtight bin, whereas it was still 38 per cent in the control. The study has shown that airtight Ferro-cement bins provide a safe and convenient method for farmers in the tropics to preserve their harvest for later sale at a higher price. Further work is necessary to develop strategies for avoiding the decrease in germination capacity. Alam *et al.* (2009) studied the performance of alternate storage devices on seed quality of boro rice. Different storage devices were used in this study. He found that germination percentage of boro seeds stored in organic cocoon was significantly highest (91%) compared to that of rexin cocoon (87%), polythene bag (80%), polythene in gunny bag (79.667) and gunny bag (68%). Seeds stored in organic cocoon performed better in maintaining higher germination due to lower moisture content (12.10%) below the critical level (14%), reduced oxygen level (4.9%) and higher proportion of dead insects (97%) caused by reduced oxygen.

METHODOLOGY

The experiment was conducted in prefabricated GIC silo. The silo was manufactured and installed by M/s Shirke Construction Equipment Pvt. Ltd., Pune. The silo was installed on a reinforced concrete platform 40 cm high from the ground level.

Paddy grains were used in this storage study. The different types of instruments were also used for the measurement of environmental parameters (temperature and relative humidity), inside the storage structure.

The temperature and relative humidity sensors position in silo is shown in Fig. B.

A data logger model TC- 800D (Make: Ambetronics) was used to record the temperature in the silo. The instrument had 8 no. thermocouple sensors of a length of 15cm and a wire of length 3m. The data store capacity of the instrument was 5000

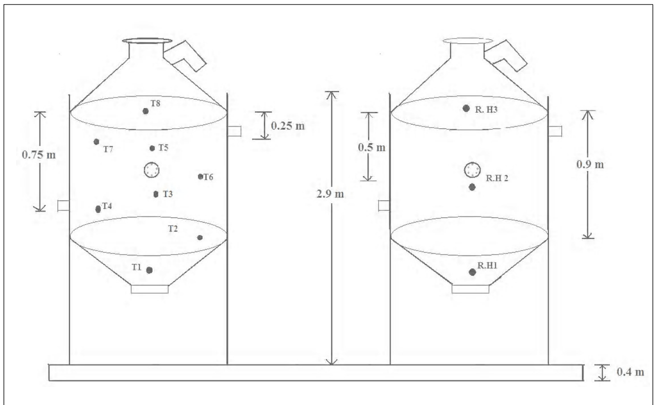

Fig. B : Temperature and relative humidity sensor position in silo

readings of all 8 no. of channels. The supply needed for the instrument was a 230V AC supply. It had a high accuracy of ±0.25 per cent and a temperature range of measurement was –200 to 400^{0}C. A temperature and relative humidity controller model TRH-401 (Make: Ambetronics) was used to record the relative humidity in the silo. The instrument measured RH between 0 – 100 per cent with an accuracy of ± 2 per cent and temperature between –40 to + 120^{0}C with an accuracy of ± 0.5^{0}C. The supply voltage was 230V AC. The sensor type for RH was a capacitive polymer sensor and for temperature, it was band gap temperature sensor.

Ambient temperature was recorded with glass thermometer (Make: Paico Deluxe). The thermometer was having temperature range from 0-100^{0}C.

Moisture content:

A hot air oven (Make: Quality Instruments, Kudal) was used in the moisture content determination. The temperature for moisture measurement was maintained at 130 ±1^{0}C and the sample was kept for 2 hrs. The moisture content was determined by AOAC. Moisture content was determined by drawing samples from the top, centre and bottom in the silo. The moisture content was calculated by oven dry method. The moisture content was determined at weekly interval. The moisture content represents here which is of dry basis (db).

■ RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Grain moisture:

The relationship between grain moisture content in GIC silo and storage period is shown in Fig. 1. The grain moisture is varied with the storage time. The initial moisture content during month of April was 13.2 per cent. While the moisture

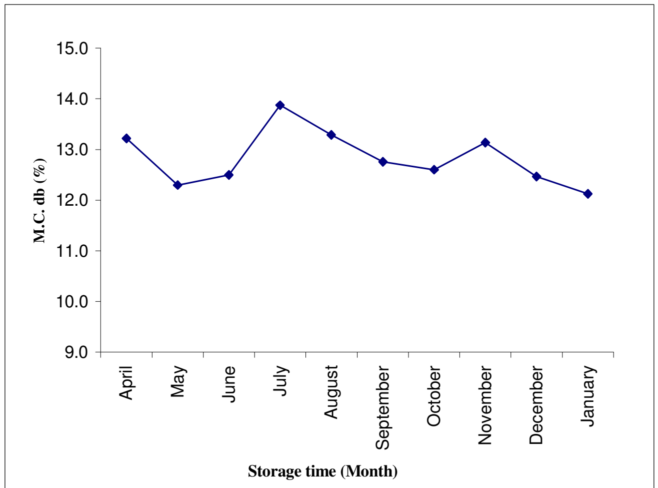

Fig. 1 : Effect of storage time (month) on average monthly moisture content of paddy in silo

content at the end of storage period was observed as 12.1 per cent. The moisture content from May to July followed the increasing trend then it followed the decreasing trend. The moisture content was not changed significantly throughout the storage period in GIC silo.

Grain temperature:

The relationship between the ambient temperature and temperature inside the silo was given in Fig. 2. Initially temperature of the grain during month of April inside silo was 29.3^{0}C while at the end of the storage period, the temperature was 26.4^{0}C. The temperature inside silo was found to be varied with the storage time. It is clear from the data that grains stored in silo for which temperature varied with ambient temperature. It may be due to the insects released heat through

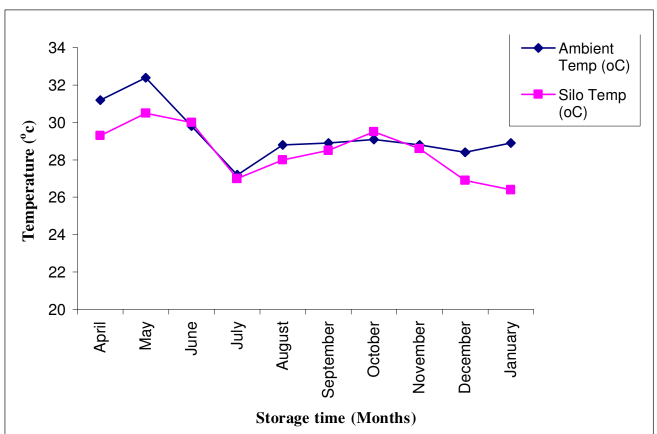

Fig. 2 : Effect of average monthly ambient temperature (^{0}C) and temperature (^{0}C) inside silo during storage month of paddy

their respiration and it was the main cause of temperature increase inside the silo. The highest temperature of 30.5^0 C was observed during the month of May.

Grain relative humidity (RH):

The relationship between the ambient relative humidity and relative humidity inside the silo with storage of paddy in months have been shown in Fig. 3.

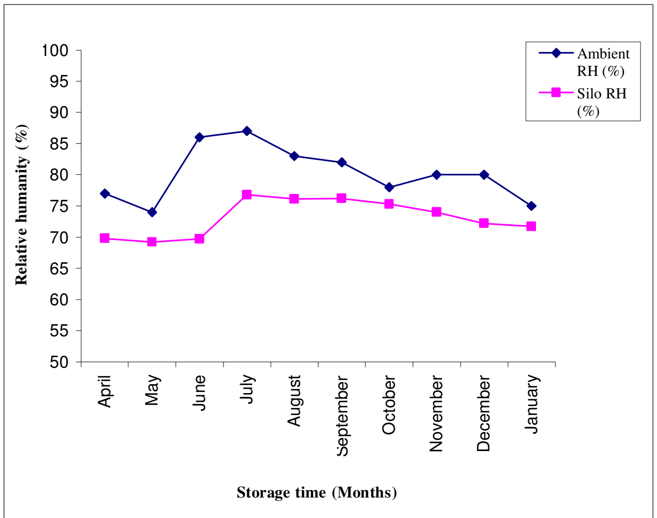

Fig. 3 : Effect of average ambient RH (%) and average RH inside silo during storage period (Months) of paddy

It was observed that the RH in silo was increased during first four months then it was slightly decreased. The relative humidity during month of April was 69.8 per cent and at the end of storage period during January, the relative humidity was 71.7 per cent. The relative humidity in the silo showed increasing trend as the storage time increased. Both the ambient relative humidity and relative humidity inside silo was observed high in rainy season (June to September). The relative humidity inside the silo was observed lower than the ambient relative humidity.

Germination percentage:

The relationship between germination percentage of paddy in GIC silo and storage period is shown in Fig. 4. The germination tests were conducted at monthly intervals. The germination percentage was assessed during the storage period. The germination percentage decreased with increasing the storage period. The insect infestation was the most important factor that affected the germination percentage. The germination percentage during the month of April was 70.6 per cent in silo storage. At the end of storage period, the germination percentage was 52.3 per cent in silo storage.

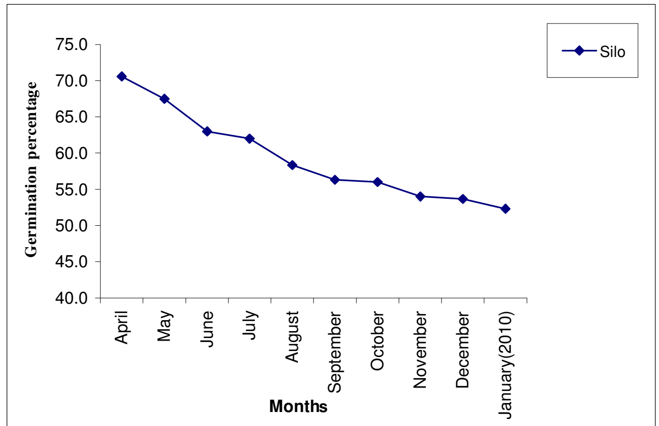

Fig. 4 : Variation of germination percentage of paddy during storage period (months)

Conclusions:

The following conclusions may be drawn from the study:

– The grain moisture in the GIC silo decreased from 13.9 per cent to 12.1 per cent with the storage time from July to January.
– The grain moisture increased from 12.3 per cent to 13.9 per cent during storage period of May to July.
– The temperature inside the silo was slightly lower than the ambient temperature.
– Initially temperature of the grain gradually declined from May to July then it slightly increased.
– The relative humidity inside the silo varied from 69.8 per cent to 71.7 per cent with storage period April to January.
– The ambient relative humidity and relative humidity inside silo was observed higher during rainy season.
– The germination percentage of grains stored in silo decreased from 70.6 per cent to 52.3 per cent during storage period of April to January.

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