Report on "Sealed storage systems for rice seed in Thua Thien Hue province, Viet Nam"[1]

An IRRI – HUAF cooperation, 2006

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Introduction

Sealed or hermetic storage systems rely on having the atmosphere within the grain modified through respiration by the grain, insects or fungi. In this system the oxygen (O_2) content in the intergranular atmosphere is dramatically reduced, often to less than 3%, and the carbon dioxide content increased to a level where aerobic respiration is no longer possible. Therefore, if we storage the good quality rice seed in this system it will maintain germination ratio, vigor higher and result in lower number of discolored seeds and insects than traditional storage systems.

The principle of sealed or hermetic storage has been around since pre historic times. Underground storage pits were excavated into the soil or rock and had supporting walls of brick or cement to prevent air from entering or leaving the storage. These old hermetic systems were often sufficiently airtight to enable insects and other aerobic organisms in the grain-mass to reduce O_2 concentrations below those permitting insect development. Modern commercial hermetic systems use higher density plastics to restrict O_2 movement. The same effect can be attained using smaller sealed plastic or metal containers.

This research compared the commercially available sealed storage cubes, also called Cocoons, and the 50kg IRRI Super bags with the traditional storage system to determine their effect on rice seed in Central Viet Nam.

Materials and Methods

The research was conducted from May 2006 to April 2007 at Dong Xuan Cooperative, Huong Tra Distrist, Thua Thien Hue Province, Viet Nam. The storage systems used were the hermetic Super bag with 50kg capacity, a hermetic Cocoon with 5t capacity and conventional PVC storage bags with 50kg as Control. A total of 4,200kg of good rice seeds with an initial germination of 90% and initial moisture content (MC) of 10.4% were stored for 12 months in these systems. After an initial sample was taken the crop was divided for the following 3 treatments:

1. The **Cocoon** was loaded with seeds bags containing 50kg each and closed. Every three months it was opened for sampling from the same bags inside Cocoon. O_2 levels were measured daily using a GrainPro oxygen meter and once per week after O_2 level had dropped below 10%.
2. The **Control** represented the traditional storage system: Three woven 50kg PVC bags were filled with seeds and placed on a pallet. Samples were taken from each bag every 3 months.

[1] Extended abstract of an oral presentation during the 3rd International Rice Congress, 9-11 November 2010, National Convention Center, Hanoi, Vietnam

3. Twelve **Super bags** were set-up as liner bags inside conventional storage bags and placed on a pallet. The bags were covered with a plastic canvas to protect them from birds and rodents. Three bags were taken out for sampling every 3 months. The remaining bags remained closed in order to keep the modified atmosphere intact. Before opening the bags the O_2 level was measured to confirm that the bags were still hermetically sealed.

The initial sample was analyzed for moisture content using the oven method, insect count, germination, and seed vigor.

Results and Discussions

Oxygen Content

A drop of O_2 level inside a hermetic container is an indicator whether the container is sealed properly. As it can be seen in Figure 1, left, the hermetic principle worked well in the Super bags. After 12 months of storage the average O_2 level had dropped to 3.4%. The slow drop is attributed to the very dry crop and the absence of mature insects in the seeds.

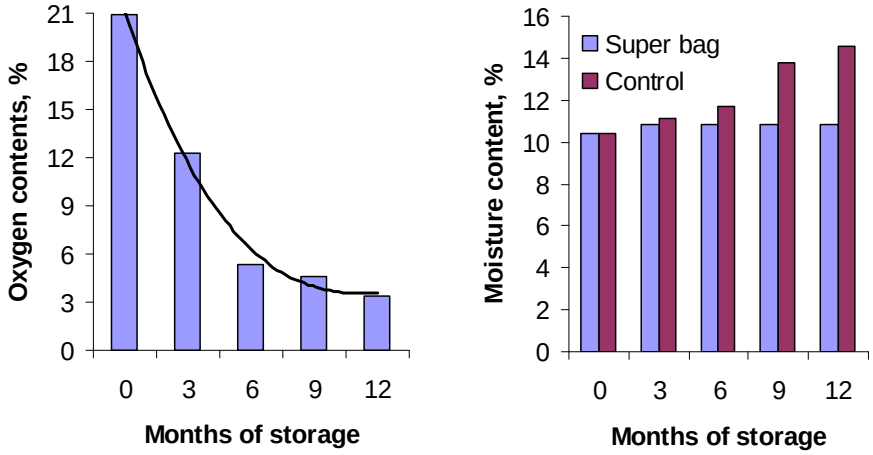

Figure 1: Oxygen contents in the Super bags (left) and moisture content in Super bags and the Control after 3, 6, 9 and 12 months of storage.

In the Cocoon the O_2 only dropped to 19.1% as lowest value indicating that the Cocoon was not sealed hermetically or damaged. Even after opening the cocoon for sampling and sealing it again the O_2 level did not drop any further. In the following therefore only moisture content and seed quality of the cocoon samples will be discussed.

Effect on Moisture Content

The initial moisture content of the samples was 10.4%. After the first 6 months storage during the dry season the moisture content of all samples had increased slightly to 11.7% in the Control and 10.8% in the Super bags (Figure 1, right). The increase in the Control was low because of low relative humidity during the dry season. From November 2006 to February 2007 the moisture content in the Control had increase significantly from 11.7% to 13.5%. When the trial was concluded in May 2007 it had increased to 14.6% which is considered unsafe for

storage. This increase happened because at that time of the year it is always rainy and relative humidity is high. In the Super bag the moisture content did not increase above 10.8% in the following 9 months. The slight increase in the sealed system may is due to water generated by respiration.

Effect on Insects

The initial sample was properly cleaned and therefore free of mature insects. In the Control the number of insect increased significantly in all samples to an average of 71 insects (alive and dead) per kg seeds after one year of storage (Figure 2, top left). The reason for the increase in insects in the Control is that the woven PVC bags are permeable for both, insects and oxygen. Therefore new infestation happened and the insects continued to breed and multiply.

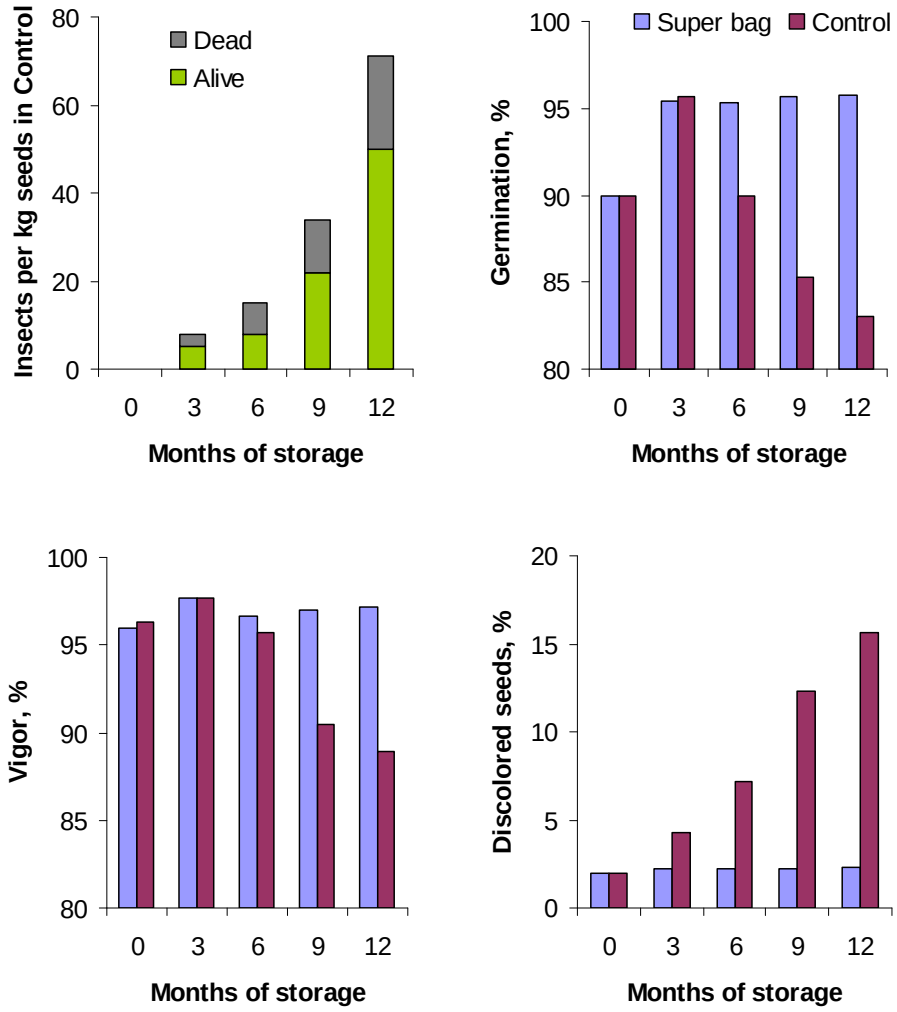

Figure 2: Insect count in the Control (top left) and seed quality traits germination (top right), vigor (bottom left) and discolored grains (bottom right) in the Super bags and the Control after 3, 6, 9 and 12 months of storage.

In the sealed storage system no insects were found even after 12 months because new infestation was effectively prevented and eggs, larvae or pupae contained in the grains could not develop because at the reduced O_2 contents they have sub-optimal living conditions.

Seed Quality

The results of the seed quality analysis for the Control and the Super bags are shown in Figure 1. The initial germination rate of all seed samples was 90% and the vigor was about 96%. After 3 months storage *both* the germination rate and seed vigor in both treatments two cases had increased. This may be because some seed were still dormant in the initial sample. Germination rate and vigor then continuously decreased in the Control to 83% and 88.9% respectively while it was more or less constant in the Super bags. The seeds in sealed storage still had germination rates about 95% and the vigor about 97% after one year. The decrease in the Control can be attributed to insect activity and higher moisture content. Similarly, discolored seeds increased significantly in the Control from 2% to 15.65% after 12 months while in the Super bags it remained at the 2% level.

Despite the high level of oxygen inside the Cocoon over the whole period the germination rate after 12 months was still at 95.6%. The moisture content was maintained at 10.7% and together with the prevention of re-infestation with insects the Cocoon was able to produce excellent seed quality even at higher oxygen levels.

Summary and Follow-up Activities

After storing seed for one year, the germination rate of the sealed storage method was higher compared to the traditional storage method. The hermetic storage is beneficial in two ways, first because the O_2 levels are reduced while CO_2 levels increase creating a modified atmosphere and second because the seeds don‘t adsorb moisture form the ambient air the moisture content is kept at safe levels. The low O_2 levels reduce the breathing process of seeds and thus the catabolism in the seed embryo. Discolored grains also stayed at a minimum and therefore it can be assumed that hermetic storage can also reduce microbiological activities and thus help maintain the quality of commercial paddy.

Based on the results of this study the Author has cooperated with the Seed Company of Tu Tinh of Hue Province on testing hermetic storage in the company’s seed storage operations. As of October 2010 the company has used a Cocoon and around 500 Super bags successfully for six cropping seasons to safely store high value foundation seeds.

Conclusions

The sealed storage included both Super bag and Cocoon provided insect Control without pesticides due to the modified atmosphere inside the storage systems. The sealed storage also limits the moisture content increase because the sealed system prevents the grains adsorbing water from the ambient air. As a result the seeds are not discolored and the seed vigor and germination rate are high even after 12 months storage.

The sealed storage method is effective, easy to use, and it is suggested that the Agricultural extension center transfer the technology to farmers for storing farmers’ seeds and to seed producers.

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