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GREEN STORAGE TECHNOLOGY

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Abstract :

Green storage technology or organic storage technology includes the techniques to store grains, seeds and perishable agricultural commodities without using chemical pesticides. It includes use of plant and plant products, natural gases i.e. nitrogen, carbon dioxide in silo, hermetic storage by placing air tight barriers between the containers having grains/seeds and ouside atmosphere so as to reduce the oxygen level in the container due to respiration of grains and insects present in the containers while storing grains. Due to air tight conditions, oxygen level deplete to lethel level and insects die. In green storage technology, there is no use of chemicals to control insect pests and microorganisms. In this article, we have reveiwed different techniques which are already developed to store agricultural commodities safely for longer period in environment friendly way.

Introduction:

In agriculture, along with growing crops in field, storing of the produce is equally important. During storage, biotic factors like insect pests are of economic importance as they cause significant losses. Abiotic factors *viz.* temperature, humidity also play important role in storage of agricultural commodities. It would be possible to fulfil the rising demands for food/ grains of the increasing population of the world, if the losses caused by insects and microorganisms in storage could be reduced. Green storage technology is the method of storing agricultural commodities for longer period without infestation of insect pests and infection of microorganisms due to stable moisture content without using chemical pesticides. Green storage technology includes hermetic storage, use of botanicals, controlled atmospere including use of carbon dioxide or nitrogen in warehouses to lower down oxygen to lethel level. Green storage technology is the organic way to control stored insect pests and moisture level in the grains/ seeds. Different techniques of green storage are reviewed and explained briefly in this article.

A. Hermetic storage structures:

Hermetic storage is the method to control insects and maintain moisture level in stored grains/ seeds by using sealed and airtight containers. It is a very effective method of maintaining moisture content in grains [i.e. moisture content (14 per cent or less) at the time of storing grain/seed] and reduce insect activity in stored grains in tropical regions. The main objective of hermetic storage is to cease the exchange of gas between the storage containers and outside atmosphere. This helps in keeping the initial levels of moisture content as such. This condition keep the seeds free of infection of microorganisms and grains as they are not attacked by diseases. Due to air tight containers, the oxygen present in the container is used by the grains and insects during respiration process. Hence, the oxygen level depletes from 21 per cent to 5 per cent which is lethal to insects and they die due to lack of oxygen. Hermetic storage structures include cocoons, super bags and conventional storage structures[1].

1. Cocoons:

Cocoons are commercially available hermetic storage structure and manufactured by GrainPro. It consists of two plastic halves which are joined together with an air-tight zipper. In these two plastic halves the grain sacks which are to be stored, are loaded and then these halves are joined together by an airtight zipper. As compared to traditional storage systems, in cocoons, the germination life of seeds can be extended. In cocoons, insect pests in grains/ seeds can be controlled without using chemical pesticides. These structures improve the head rice recovery of stored paddy[2].

2. Super bags:

The super bags also work on the same principle as of hermetic storage of grains/ seeds. These super bags are available in 50 and 100 kg sizes also. Super bags are used as liners to conventional jute or woven polypropylene bags. In IRRI Super Bags, farmers can store sorghum, wheat, pulses, corn and rice and other expensive commodities such as spices, cocoa, coffee and various hybrid seeds safely for longer period[3].

3. Locally available containers :

They are useful in rural areas and also useful for household purpose. The locally available containers can be easily converted into hermetic storage systems. The commonly available containers may include water bottles, vegetable oil containers, etc. In African countries, about 5 to 20 litre vegetable oil containers are commonly used in villages to store beverages. In Bodhgaya (Bihar), earthen pots are used as indoor storage containers for storing small quantity of grains. These are made up of locally using burnt clay and are of different shapes and sizes. In Rajasthan, grain stores are called Kothas. Kothas are used to keep the grain and also perishable material like milk and curd or even any other food item which need to be kept fresh. It is constructed using pond's mud mixed with a bit of straw (no cow dung). The external white coating is done using a white mud diluted in water. In Maharashtra, Warli grain storage container made out of local reeds and plastered with dry teak leaves that are insect repellent. Dried leaves are used to protect stored grains because their odour repels insects[4].

B. Use of botanicals :

Green storage technology also includes use of botanicals i.e. plant and plant products to control the stored grain insect pests organically. This is safe, low cost, locally available alternative method to reduce grain/seed losses by preventing storage losses from pests. Till date number of investigators worked on botanicals, isolated and identified chemical compounds from leaves and seeds of many plant species as potential pesticides. For example, juniper, rosemary, neem, eucalyptus, peppermint, citronella products

have been reported to be effective in controlling several insects in storage[5,6,7].

Mulungu**,** L.S., *et.al.*[8]observed that pawpaw (*Carica papaya* L.) leaf powder was effective in reducing the number of live insects, *Sitophilus zeamays* on stored maize. Similarly, number of damaged seeds was relatively less in grains treated with pawpaw leaf powder.

Da Silva, K. F., *et.al.*[9] found that the powder application form of botanicals was more efficient in controlling mexican bean weevil, *Z. subfasciatus* infesting bean grains (*Phaseolus vulgaris* Linnaeus). *Azadirachta indica* (powder application), *Ruta graveolens* (powder application), and *Piper aduncum* (TNT bag) reduced the infestation of adults. The species *A. inidica, Piper tuberculatum, Trichilia catigua, Pfaffia glomerata, R. graveolens,* and *Mentha pulegium* inhibited the oviposition of the insects no matter what the formulation applied. *R. graveolens* (powder application) caused 100% of mortality. The powder application of *R. graveolens* and *M. pulegium* reduced egg viability and insect emergence; therefore, they were found to be very promising alternatives to control *Z. subfasciatus* in stored grains.

Lal, M., *et.al.*[10] reviewed the importance of different plant products (botanicals) against storage insect pests of seeds and grains. Among various storage insect pests *Sitotroga cerealella, Sitophilus* sp., *Rhyzopertha Dominica, Trogoderma granarium, Tribolium* sp., *Callosobruchus* sp. etc. are major. Insect damage include consumption of seed, debris of exuviae, webbing, and cadavers thereby makes the grain unfit for human consumption and also reduce quality as well as quantity. They manipulates storage environment resulted in development of hotspots which are congenial for the proliferation of storage fungi and other harmful micro flora. Biodegradable, non-residual, equally effective and easily available botanicals such as neem (*Azadirachta indica*), bach (*Acorus calamus*), phoolakri (*Lantana camara*), draik (*Melia azadarach*), kali mirch (*Piper nigrum*), Basuti (*Adhatoda zeylanica*) etc. may prove to be a better option to control insect pests including storage pests without affecting the quality of grains or seeds and without harming ecosystem. Thus botanicals may be recommended alone or as a part of IPM to control insect pests.

C. Controlled atmosphere storage

Generally, the poisonous gases like phosphine are used in warehouses for control of insect pests in storage. But in controlled atmosphere system, the normal gases of the atmosphere can be altered to achieve control. The use of natural components of the atmosphere, i.e. oxygen, nitrogen and carbon dioxide are used to preserve food. This is referred as "controlled" or "modified" atmosphere storage. Controlled atmosphere techniques are mostly used in the storage of perishable commodities like fruit, vegetables, cut flowers, etc. which retard ripening and reduce spoilage from micro-organisms. The controlled atmosphere storage are mostly used for controlling insect pests in storage. The atmospheres are modified by removing oxygen or by adding high levels of carbon dioxide which kill insects directly. In these treatments, the modified atmospheres are maintained for a long period to kill all stages of insects. These atmospheres do not have any adverse effect on the commodity[11].

1. Use of carbon dioxide in warehouses [12] :

For controlling insect pests in storage, carbon dioxide is an alternative option to commonly used fumigant i.e. phosphine. Carbon dioxide is easier to manage in smaller, air-tight silos less than 300 tonnes. The application of carbon dioxide in silos involves replacement of oxygen with carbon dioxide to a

concentration which is toxic to insects over an extended period.

To keep the modified atmosphere constant and to get the successful control inside the silo, it should be gas-tight. Small air leakages are also not allowed because it cause carbon dioxide gas to escape and oxygen to re-enter. Entrance of oxygen cause failure to control of all insect pests in the silo. For effective control of all insect pests, carbon dioxide should be applied in gas tight silo for at least 15 days. Carbon dioxide is released into the bottom of the silo, air is forced out through the opened silo top lid or vent. Each cylinder may take about three hours to distribute 30kg carbon dioxide. When the target concentration level of 80-90 per cent carbon dioxide is reached at the top of the silo, the gas is turned off and the top lid is sealed. The minimum required concentration of carbon dioxide should be not less than 35 per cent for 15 days to get the effective control of all insect species except *Trogoderma* spp. at all life stages. The temperature should be 20^0C or above. Carbon dioxide is less effective at grain temperatures below 20^0C and hence required longer exposure period[12].

2. **Nitrogen application in warehouses[13] :**

In green storage technology, 99 per cent nitrogen gas is dispensed in the storage structure to get effective control of stored grain insect pests. Main aim of this technique is the exclusion of oxygen levels from 21 per cent to less than 1 per cent oxygen concentration. Nitrogen gas (99 per cent) is delivered at the base of the silo. This helps in completing at least two air changes to reduce oxygen levels to less than 1per cent which measured in the head-space at the top of the silo[14]. Use of nitrogen in warehouses maintain grain quality. High nitrogen atmosphere helps to maintain colour of stored pulses and oilseeds. Eg. Lupins, Chickpeas, Canola.It also affects oil content quality. Because of low oxygen level in storage, less oxidation of oils in oilseeds takes place. Hence the oil content in oil seeds do not reduce. Eg. canola, sunflower, linseed. Due to high nitrogen level, oxygen level reduce up to 1 per cent. Because of reduction of oxygen to lethel level, insect pests in storage die. Hence effective control can be maintained. Use of nitrogen in warehouses is safe and do not create health issues. Venting of grain is not required. It is safe as compared to phosphine fumigation for pest control.

Conclusion :

Green storage technology includes different methods of keeping the grains/ seeds free of insect infestation without using chemical pesticides. It promotes the use and manipulation of natural gases to create modified atmospheres in the storage structures to reduce insect pest attack without using poisonous fumigants like phosphine. Hence, in my view, this is the best emerging technology and the organic, ecofriendly way of storing grains for longer period.

REFERENCES :

1. https://www.researchgate.net/publication/316379137_Hermetic_Seed_Storage_Technology. 21/06/2018.
2. http://www.knowledgebank.irri.org/step-by-step-production/postharvest/storage/grain-storage-systems/hermetic-storage-systems/cocoon. 21/06/2018.
3. http://www.knowledgebank.irri.org/step-by-step-production/postharvest/storage/grain-storage-systems/hermetic-storage-systems/irri-super-bag. 21/06/2018

4. http://www.iskconvarnasrama.com/home/traditional-ways-of-storing-grains. 27/06/2018

5. Hashemi SM and Rostaefar A. (2014). Insecticidal Activity of Essential Oil from *Juniperus communis* L. subsp. *hemisphaerica* (Presl) Nyman against two stored product beetles. Ecologia Balkanica. 6 (1): 87-93.
6. Singh,V. (2016). Phytotoxic Efficacy of Rosemary Oil Against *Tribolium Castaneum* and *Callasobruchus Maculatus* Global Journal of Science Frontier Research: C Biological Science.16 (3): 59-63.
7. Ahmed, M.E. and El-Salam, A. (2010). Fumigant toxicity of seven essential oils against the cowpea weevil, *Callosobruchus maculatus* (F.) and the rice weevil, *Sitophilus oryzae* (L.) Egypt. Acad. J. biolog. Sci., 2 (1): 1- 6.
8. Mulungu**,** L.S**.,** Lupenza **,** G**.,** Reuben, S.O.W.M. and Misangu, R.N. (2007). Evaluation of Botanical Products as Stored Grain Protectant Against Maize Weevil, *Sitophilus zeamays* (L.) on Maize. Journal of Entomology. Volume 4 (3): 258-262.
9. Da Silva, K. F., Baldin, E.L.L. and Da Rocha pannuti, L. E. (2016). Use of botanical insecticides as an alternative for the management of the mexican bean weevil. Revista Caatinga, Mossoró, v. 29, n. 2, p. 348 – 357, abr. – jun., 2016
10. Lal, M., Ram, B. and Tiwari, P. (2017). Botanicals to Cope Stored Grain Insect Pests: A Review. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 6 Number 6 (2017) pp. 1583-1594.
11. http://www.fao.org/docrep/X5042E/x5042E0o.htm. 28/06/2018
12. http://storedgrain.com.au/carbon-dioxide-co2. 26/06/2018
13. http://storedgrain.com.au/nitrogen-notes-use-stored-grain. 28/06/2018.