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Rice Weevil: Eco-Friendly Non-Chemical Methods of Management

Larger dependence on synthetic pesticides for storage pest management has led to considerable problems like residues in products, pest resurgence and resistance in insects. A fast, more sensitive and economically feasible method for detection of infestation by seed storage pests is the need of the hour. In this context, few nonchemical methods gain importance as an alternative to chemical fumigants which may have a deleterious effect on the seed quality parameters.

INTRODUCTION

Harvested produce like seeds/grains are attacked by several insect pests during pre and post harvest storage, resulting in both quantitative and qualitative loss. Rice and wheat are staple food grains in our country with an estimated production of 127.93 and 111.32 million tonnes, respectively (PIB, 2022). Among the major storage insects of cereals, rice weevil *Sitophilus oryzae* L. is the most notorious one and it damages a range of cereals. It is prone to get infested by *S. oryzae* stored for long time that gradually leads to severe economic loss due to stale off odour and unfit for human consumption. Adult weevils make circular holes in the grain consuming largely the endosperm, reducing carbohydrate content. The larvae usually feed on the grain germ, consuming a significant quantity of protein and vitamins. High grain moisture content (>12%), high relative humidity (>70%), and high temperature (>27%) favour the growth and development of the weevils leading to stale taste and off odour in grains.

Chemical fumigation is currently the most used method to control these pests due to their efficacy and application easiness. Indiscriminate use of such synthetic insecticides has raised health,

and environmental issues like ozone-depletion, phosphine resistance etc. Another ecological aspect is that chemical fumigation is effective well sealed closed environment and the grain temperature is above 10°C. In this context, focus towards more sensitive and cheap methods is a requisite for sustaining the storability of seeds for long term.

PHYSICAL METHODS

Appropriate management of three factors viz., temperature, seed moisture and oxygen availability will aid in increasing the shelf life of seeds under storage. All these factors are essential for normal rapid development and multiplication of insects. Hence, manipulation of these factors through design and construction of storage structures/godowns and following hygienic storage practices will decrease the congenial conditions for their multiplication. For example, temperature above 42^0C and below 14^0C retards insect growth and development. But high temperature above 50^0C is not advisable as it affects the seed viability. Similarly, seeds stored at less than 12 per cent moisture content escape from most of the storage pests. Reduced oxygen or increased carbon dioxide levels also affects their survival.

MECHANICAL CONTROL MEASURES

Several mechanical devices have been devised to monitor and manage storage insect pests like probe traps, light traps, pheromone traps etc. Rapid and non-destructive methods like X-ray imaging, nuclear infrared reflectance (NIR) spectroscopy have been extensively studied currently against storage insects. They can detect even intermediate stages like larva and unseen insect infestation which may be ignored in manual inspection. Disadvantage is that the cost of these technologies is relatively high and requires expertise.

BOTANICALS

Several plants have been reported to possess antifeedant, repellent, growth disrupting and toxic properties against insects. Some of the local products from plants like *Zanthoxylum armatum*, *Acorus calamus* L., *Allium sativum* L, *Zingiber officinale* Roscoe, *Azadirachta indica* A. Juss, *Piper nigrum* (seed powder), *Carica papaya* (Papaya leaf powder) @ 10g/Kg seeds etc have been found to be very effective in controlling stored grain pests. β-asarone found in stolon's of sweet flag has an insecticidal property, whereas dried rhizome possesses antifeedant property. Mixing of seeds with dried leaves of neem (*Azadirachta indica* A. Juss) is a conventional method for insect control since decades. Fumigation with these powders lead to suffocation and death of storage insect pests. Piperine in black pepper extract and cinnamaldehyde from cinnamon are such pungent substances reported to possess insecticidal activities. These have no adverse effects on human health system but has its own limitations for short term effect on the insects.

BIOLOGICAL CONTROL

Some of the hymenopteran parasitoids like *Anisopteromalus calandrae* (Howard), *Lariophagus distinguendus* (Förster), *Pteromalus (Habrocytus) cerealellae* (Ashmead) and *Theocolax* (Choetospila) *elegans* (Westwood) has been reported to attack rice weevil. These parasitoid species has the ability to detect prey and has wide host range. Entomopathogenic fungi (EPFs) is another group of natural enemies like *Beauveria bassiana*, *B. brongniartii*, *Isaria farinosa*, *I. fumosorosea*, *Lecanicillium* spp., and *Metarhizium anisopliae* attracting attention as a potential biological control agent. Usage of EPFs for the control of stored-grain insect pests is one of the most promising alternative control methods for chemical means. Especially, *B. bassiana* and *M. anisopliae* have a wide host range and worldwide commercial importance against most of the major stored-grain pests. These entomopathogens are effective at lower temperatures for example, *B. bassiana* at 26 °C

against *S. oryzae; Isaria fumosorosea* at 20 °C. Effectiveness of these bioagents depends on the target insect species, its life stage available, exposure time and temperature.

INERT DUSTS

Inert dusts are mineral earths used to protect stored grain from insect attack. They include all dry powders of different origins which are chemically un-reactive in nature. Commonly used inert dusts are clay, sand, ground phosphate, ash, diatomaceous earths, amorphous silica etc. For example, amorphous silica form of DE is commonly used as grain protectant. DE's have the advantage of low mammalian toxicity. A wide range of insect species has been managed through this method.

Inert dusts provide long term protection, no chemical residues, maintenance of grain quality and safe. Inert dust in the form of silicates/silica dust is effective grain protectant in controlling postharvest insect pests. The residual toxicity of silica gel has long-term protection in concealed packages against stored-product insects. But, it must be noted that usage of high dose rate of IDIs may sometimes lead to loss of grain bulk density and flowability. High humidity and grain moisture content reduces the effectiveness of inert dusts.

NANO PARTICLES

In the recent decade, nano-technology has a major role in minimising post-harvest storage losses caused by insects. Nano-size of the particles has advantage of increased surface area and hence more reactive in nature. Several workers have studied the entomotoxic efficacy of nanoparticles on different insect pests and grain products. Inert dusts like silica, clay and alumina in the form of nano particle are now widely used for stored pest management. Amorphous silica nano particles are reported to have insecticidal property due to narrow size distribution. Hydrophilic nano silicate at 20 mg/kg and Aerosil 200 nano particles at concentration of 2.5 g/kg has been reported (Boraei and Nilly, 2015) to mortality of *S.oryzae*. Percent adult mortality of *S. oryzae* when, nano silica was applied @ 2 mg kg^{-1} of paddy. Mortality reason could be attributed to uniform distribution of the nano particles all over the insect body resulting in abrasion of the insect cuticle. Later insect dies due to loss of water from the body and also defacing of the mandibles. The residues can be removed during conventional milling process unlike pesticide residues which have longer persistence.

CONCLUSION

Stored grains and insect infestation are two sides of a coin which is inseparable. Timely detection and identification if the infestation is very important to improve the storability of harvested produce. In this, some methods have high sensitivity towards detection of the presence or absence but will be relatively costly and not affordable to the small-scale farmers. While cheaper methods lack detection sensitivity. In the recent years, volatile isolation techniques can be a potential alternative approach for early detection of insects in stored grain. These are non-destructive methods wherein the volatiles released by seeds are trapped using either dynamic head space-GC or solid phase micro extraction and further identify the metabolites and pheromones with GC-MS which are the unique characteristic of particular insect pests. E-nose application to grain with the advantage of detecting insect infestation is also slowly expanding. Volatile isolation techniques have moderate sensitivity and hence feasible method. Therefore, it appears to be an attractive technique to be used as an alternative approach to detect insects in stored grain. Among the discussed alternatives, use of a single method may not solve the current pesticide resistance problem in stored product pests. Rotation of two or more control methods or combination of

techniques should be considered as a sustainable and long-term strategy for stored grain/seed insect pest management.

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