

# Inert Dusts -Better Alternatives for the Management of Angoumois Grain Moth, *Sitotroga cerealella* in Stored Rice

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**Abstract:** The efficacy of different indigenous inert materials viz., Cow dung cake ash, Paddy husk ash, and two commercially available diatomaceous earth formulations viz., diatomaceous earth and indispron P406 @ 2.5g and 5 g /kg seed were evaluated against stored grain pests of rice. The freshly harvested rice with high germinability and vigor was treated with these inert materials and kept under ambient conditions for further storability studies. Among the different inert materials, indispron P406 @ 2.5 and 5g/kg and diatomaceous earth @ 5g/kg were found to be effective against *sitotroga cerealella* upto Twelve months of storage of rice with less insect damage (<0.5%) compared to deltamethrin (6.38%) and untreated control(8.73%). Germinability of seed also maintained for 12 months which is above certification standards (>80%) in the indispron P406 treated rice seeds. These eco-friendly inert dusts can be recommended as seed protectants to save the rice seed against stored grain pests for longer periods.

**Keywords:** Inert dusts, Stored grain pests, Rice, *Sitotroga cerealella* , diatomaceous earths

## 1. Introduction

India is one of the leading rice producing countries of the world accounting to 20% of global rice production. Rice has been the staple food crop and constitutes about 52% of total food grain production and 55% of total cereal production in India. Among different rice producing States in India, Andhra Pradesh is the "Rice Bowl of India", and has an annual production of 14.4 million tones. Storage pests of rice are a major threat and cause significant economic losses worldwide. It is estimated that 5-10% of world's grain production is lost due to ravages of insects [1]. According to World Bank Report (1999), post-harvest losses in India amount to 12 to 16 million metric tons of food grains each year, an amount that the World Bank stipulates could feed one-third of India's poor. The monetary value of these losses amounts to more than Rs 50,000 crores per year [13]. Food grains wasted during post-harvest period could have fed up 117 million people for a year. Storing grain in storehouses to keep them free from being damaged by insect pests is a problem which is confronted by every rice farmer in India.

The Angoumois grain moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) is one of the serious insect pests of stored grains in India. It is cosmopolitan in distribution. Its young larvae bore into grains and feed on the inside contents rendering grains unfit for human consumption. The management of this insect pest mainly depends on the use of fumigants and synthetic insecticides since long time. In recent years, consumer awareness of the health hazards from residual toxicity and the growing problem of insect resistance to these conventional insecticides have led the researchers to look for alternative strategies for stored grains protection. With the ever increasing emphasis on reduction of environmental contamination, inert dusts will play a significant role in replacing synthetic conventional chemicals as grain protectants. The diatomaceous earth (DE) is considered to be used as an alternative to the traditional insecticides [18]. The DEs have a natural origin as they are composed of the fossils of diatoms and also reported to have

very low mammalian toxicity [3], [5], [8] and [18] observed that the DEs in general acted as the desiccants when applied on the cuticle of insects and ultimately insect dies due to the excessive loss of water from the body.

There has been comparatively little work done in India on effectiveness of alternative indigenous inert dusts on *S. cerealella* in stored rice. Hence, this study aimed to test the effectiveness of diatomaceous earth, silicon aerosol dust material, indispron- P406 and other indigenous inert dusts like cow dung cake ash and paddy husk ash against the damage caused by Angoumois grain moth, *S. cerealella* and other quality attributes of rice seed like germination and vigour of seed under storage conditions.

## 2. Methodology

A trial was conducted during 2008 and 2009 in the Seed Entomology laboratory, Seed Research and Technology Centre, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh, India.

### 2.1 Inert dusts

The inert dusts viz., cow dung cake ash, paddy husk ash, diatomaceous earth and indispron- P-406 at two test doses along with chemical check deltamethrin has been tested as seed protectants against storage pests of rice at different storage intervals.

### 2.2 Experimental procedure

Each inert dust at the test doses of 2 g and 5g per kg seed was added to rice seed and then vigorously mixed by shaking well in a big plastic container so that the inert dust will be coated well on the surface of the seed. Then it was shade dried and then the seed was filled into non-woven HDPE bags and kept under ambient conditions. Storage studies were conducted by recording data on germination of seed, insect damage and seedling vigour index at three

months interval. The standard germination test was conducted as per the ISTA rules by adopting the rolled paper towel method [19]. Percent damage, Seedling vigour index and weight loss were calculated by using the following formulae

$$\text{Insect damage (\%)} = \frac{\text{No. of damaged grains} \times 100}{\text{No. of Total grains}}$$

$$\text{Avoidable loss (\%)} = \frac{\text{Wt. of control sample} - \text{Wt. of Test sample}}{\text{Wt. of control sample}} \times 100$$

Seedling vigour index = Germination (%) x Seedling length (cm).

The data were subjected to suitable statistical analysis using one-way analysis of variance (ANOVA).

### 3. Results and Discussion

#### 3.1 Effect on Germination of seed

There were no significant differences in the seed germination up to three months of storage and all the treatments maintained > 90% germination and on par with untreated control (84.67%). But the germination was dropped to 76 % in the untreated rice seed after six months of storage (Table 1).

All the inert dusts under study viz., indispron- P406 , diatomaceous earth, rice husk ash and cow dung cake ash were found to be effective in maintaining the germinability of seed above certification standards (>80%) up to nine months of storage compared to deltamethrin (86.67% and control (73%). Even after 12 months of storage, indispron-P406 @ 2.5 and 5 g/kg seed and diatomaceous earth @ 5 g/kg seed were performed better than deltamethrin(78%) in maintaining the viability of seed above certification standards(>80%) where as the germinability of seeds were dropped down to 53 % in untreated control.

#### 3.2 Effect on Seedling vigour index

The data in table 1 revealed that there were no significant differences between treatments up to three months of storage of rice seed but the highest seedling vigour index was recorded with diatomaceous earth (2163) and Indispron P406 (2153) compared to control (1762). Significant differences in the vigour of seedling was recorded after twelve months of storage (Fig. 2) where the lowest vigour was recorded with untreated check (952) and cowdung cake ash @ 5g/kg seed (742) compared to highest vigour of 1850 with indispron P406 treated seeds.

#### 3.3 Effect on avoidable weight loss (%)

Significant differences in the weight loss were recorded even at three months after storage where untreated control recorded 7.14 % weight loss followed by 2.38% loss with cow dung cake ash and there was no weight loss recorded with the other treatments (Table1). But 12 months after storage (Table 1 and Fig. 2), indispron P406 and diatomaceous earth @ 5g/kg seed were found to be effective seed treating dusts with no weight loss compared to highest

weight loss of 35.23% with untreated control and 14.29% loss with chemical check deltamethrin. (Fig. 2)

#### 3.4 Effect on moisture (%) of the seed

As per the data in Table 1, there was no significant difference in moisture content of seed up to nine months of storage. But there was slight increase in moisture content of seed treated with deltamethrin and untreated control (> 12%) compared to rice husk ash (10%) and diatomaceous earth (11%) after 12 months.

#### 3.5 Effect on Insect damage (%)

The data recorded on insect damage (Fig 1.) indicated that all the inert dusts viz., indispron P406, diatomaceous earth and rice husk ash were found to be effective against *S. cerealella* with no insect damage up to three months of storage compared to deltamethrin (2.38%) and untreated control (8.09%). But after six months , indispron P406 was found to be significantly superior to all other treatments with no insect damage followed by diatomaceous earth @ 5 g/kg seed (1.67%) compared to deltamethrin (4.69%) and untreated control(9.68%) . The highest insect damage of 17.67% was recorded with untreated control after 12 months of storage (Fig. 2) where as indispron P406 maintained its efficacy with low insect damage (<0.28%) followed by diatomaceous earth @ 5 g/kg seed (2.64%) compared to all other inert dusts under study (> 10%) and chemical check deltamethrin (7.42%).

The use of inert dusts, particularly those based on silica are the commonly used stored grain protectants [7]. Among them, DE composed mainly of amorphous micron sized silica has become most popular [4], [12], [10] as an alternative to the conventional pesticides which have mammalian toxicity.

Various studies on the efficacy of inert dusts have been reported. Attapulgit based clay dust was shown to control *Corcyra cephalonica*, *Tribolium castaneum* and *Caryedon serratus* when applied to groundnuts at 0.5%(Mittal and Wightman,1989).The effect of different DEs on various stored product insects was studied by numerous researchers [4], [5], [12], [3] , [10], [8], [11], [2], [14]. [8] found that on the same commodity, there was a significant variation in the susceptibility of different insect species to the inert dusts. In another test where Dryacides was applied at various rates on the grain surface, and combined with cooling, few insects of any species were trapped during a nine-month study, and no progeny developed from incubated samples [20]. [16] evaluated the efficacy of Dryacides and Protect-It's against *Prostephanus truncatus* (Horn) (larger grain borer), *Sitophilus zeamais* Motschulsky (Maize weevil), *Callosobruchus maculatus* (F.) (cowpea weevil), and *Acanthoscelides obtectus* (Say) (common bean weevil) at different rates and humidities, and a storage period of up to six months on stored maize, cowpeas, and red kidney beans. The insecticidal value differed among the species, and it was suggested that dosages of the product should be based on the diversity of insects within the grain bin environment.

In other pest species such as *Tribolium castaneum*, *Oryzaephilus surinamensis* and *Plodia interpunctella* adult emergence in maize treated with Insecto® (DE) at a rate of 1 g kg<sup>-1</sup> was decreased by 98-100% [9]. Similarly, a minimum of 0.5 g kg<sup>-1</sup> Dryacide was found to be sufficient for progeny suppression of *R. dominica* [15]. According to [6] progeny production of *R. dominica* decreased with the increased rate of DE (Protect-It®) and *R. dominica* population was suppressed at 1.0 g kg<sup>-1</sup> DE. [17] reported that Dryacides caused a 100% mortality rate for populations of *R. dominica*, *Sitophilus oryzae* (L.) (rice weevil), and *T. castaneum* (Herbst), the red flour beetle, at a rate of 1000 ppm at 65% RH and 20± 1°C. Our findings are consistent with those published previously for *R. dominica* and other stored-product insect pests.

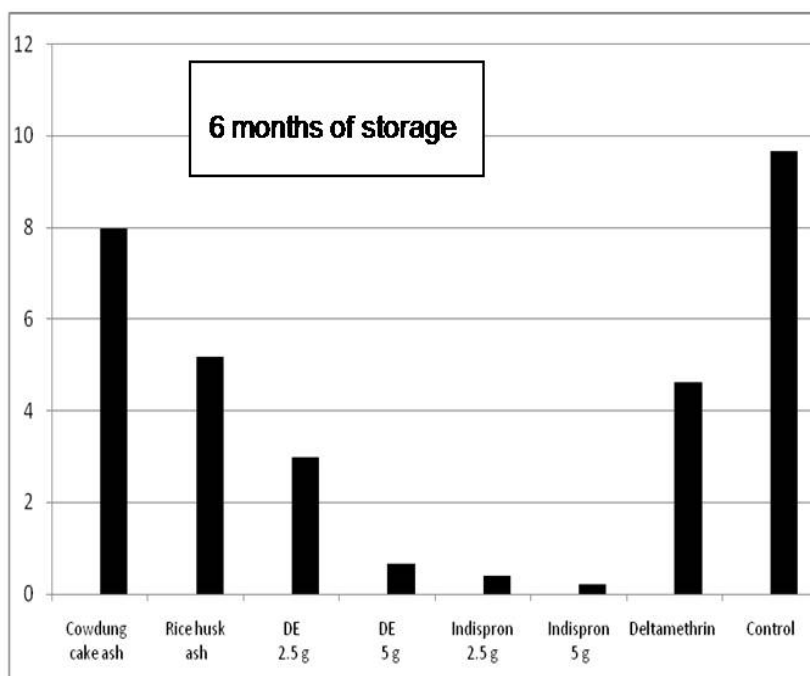
The results of present study emphasized the potential of non-chemical, residue free, indigenous and silica based inert dusts like indispron P 406 and diatomaceous earth in rice seed storage and can be used as alternatives to conventional insecticides like deltamethrin for long term safe storage of seed. These inert dusts are safe, cheap and eco- friendly materials that can fit into the IPM package of stored grain pests.

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**Table 1:** Effect of inert dusts on seed quality parameters in rice during storage

Treatments	Moisture (%)				Germination (%)				Vigour index		Avoidable loss (%)	
	Months after storage								3	12	3	12
	3	6	9	12	3	6	9	12				
Cow dung cake ash @ 2.5g/kg	9.70	9.83	12.53	11.07	91.00	76.67	71.67	46.67	1974	1029	2.38	9.52
Cow dung cake ash @ 5g/kg	9.53	10.03	12.57	10.80	91.00	85.00	81.67	54.67	2005	742	0	4.76
Rice husk ash @ 2.5g/kg	9.70	10.10	12.57	10.08	90.67	91.67	91.00	51.33	2128	1038	0	19.05
Rice husk ash @ 5g/kg	9.67	10.00	12.57	10.10	91.33	91.00	90.00	64.33	1830	1194	0	9.52
Diatomaceous earth @ 2.5g/kg	9.63	10.17	12.40	11.17	90.33	91.33	89.33	62.67	2139	1242	0	9.52
Diatomaceous earth @ 5g/kg	9.57	10.20	12.67	11.07	91.33	91.00	90.33	80.33	2163	1539	0	0
Indispron P 406 @ 2.5g/kg	9.57	10.17	12.37	11.03	92.00	89.67	88.33	80.67	2153	1653	0	4.76
Indispron P 406 @ 5g/kg	9.50	09.97	12.07	11.00	92.33	92.00	91.67	85.00	1924	1850	0	0
Deltamethrin @ 40mg/kg	9.80	09.77	12.57	12.00	87.33	86.00	86.67	78.00	1949	1522	0	14.29
Control	9.70	10.13	12.70	12.33	84.67	76.67	73.00	53.00	1762	952	7.14	35.23
F-Test	NS	NS	NS	NS	Sig	Sig	Sig	Sig	NS	Sig	Sig	Sig
CD at 5%		-	-	-	0.29	7.85	6.87	8.11	-	196.53	-	-



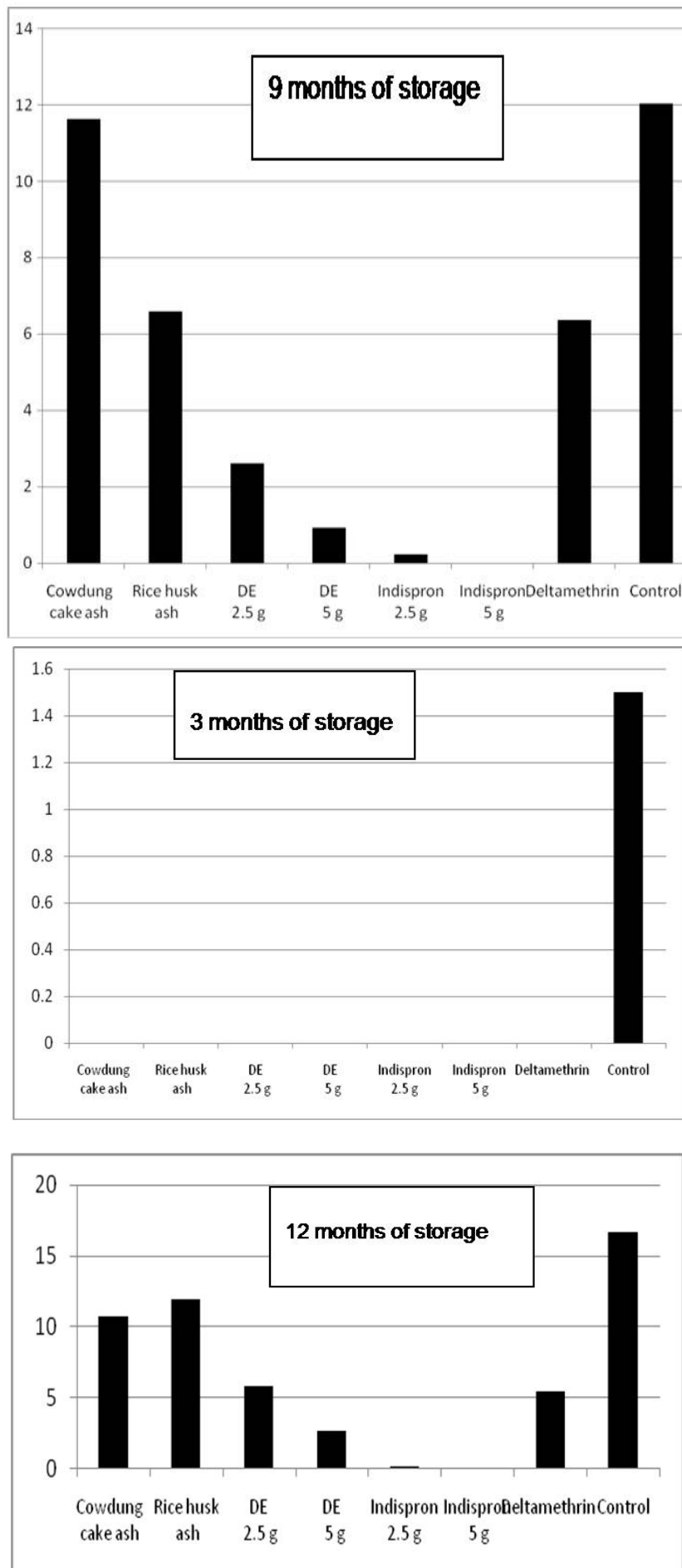


Figure 1: Effect of inert dusts on damage caused by *Sitotroga cerealella* to rice seed during storage

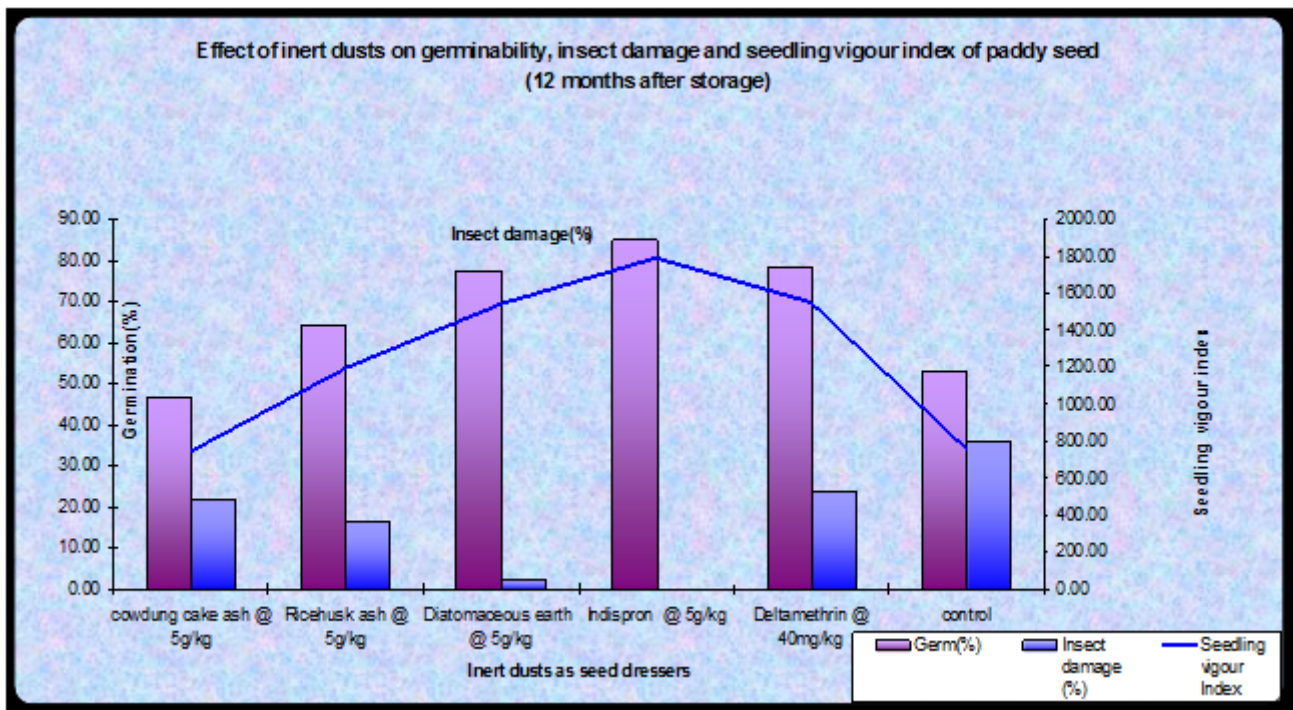


Figure 2: Effect of inert dusts on germination, vigour and insect damage of rice seed after 12 months of storage

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