Management Practices against Angoumois grain moth, *Sitotroga Cerealella* (Olivier) in Stored Paddy in Nagaland, India

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Abstract

Sitotroga cerealella (Olivier) is one of the most destructive insect-pests of Nagaland. Experiments on management practices during the year 1998-1999& 1999-2000 are stated below. Highest efficacy among 12 plant materials was shown by *L. citrata* seed powder @ 10g kg^{-1} throughout the period of study; lowest result was in *A.indica* oil cake @ 5 g kg^{-1} at 2 months, *Z.oxyphyllum* leaf powder@ 5 g kg^{-1} at 4 and 6 months of storage. Malathion @ 1.5 g kg^{-1} was the best treatment in all the months of storage. *Ahning* with *Tsakvong* indicated that the pest result out of 8 storage structures whereas gunny bag storage showed the highest infestation in all the months of storage. Best germination was presented in *Ahning* with *Tsakvong*. Analysis of correlation coefficient (r) of percent germination of seeds with infestation percentage of *Sitotroga cerealella* had indicated inverse relation infestation with germination percentage. Estimates on linear regression coefficient (b) for germination percentage of rice seeds with infestation percentage of *Sitotroga cerealella* was carried out in all the parameters.

1. Introduction

Storage of harvested crop without loses or damage is of natural importance. Angoumois grain moth, *Sitotroga cerealella* is the foremost insect pest in paddy storage (Prakash et al., 1987). It does not only infest grains in storage but also attack major paddy crop in the field (Prakash et al., 1984, Bordoloi,1990). Inclusion of resistant varieties is an important component in the management programme of any pest. Pandey and Raju (2003) reported on the incidence of *S. oryzae, S. cerealella* and *R.dominica* on stored maize and paddy in different storage structures/practices in North-Eastern region. Of all the six types of storage structures used, none were efficient for protection. Use of plant products against insect pest is thus imperative, Prakash and Rao (1997) indicated usage of plant products as protectants against insect-pests when grains are preserved for human consumption. Considering the importance of *S.cerealella,* we evaluated 8 indigenous storage structures and tested the efficacy of 12 plant materials against *S.cerealella* of stored paddy during the year 1998-2000 in the Entomology Laboratory, Nagaland University, SASRD, Medziphema, Nagaland, India.

2. Material and Method

Eight (8) indigenous storage structures viz, *Ahning* (Bamboo structure), *Ahning* with *Tsakvong* (Bamboo structure and cone), *Chunuo* (Bamboo structure), *Telha ki* (wire net and bamboo), gunny bag, *Mer* (Bamboo structure), metallic drum, *Ale* (made of bamboo) used by farmers in different districts of Nagaland were evaluated during 1998-99 and 1999-2000. Paddy seeds were drawn from top, middle and bottom of the storage structure. 12 plant products were used in 2 doses @ 5 g kg^{-1} and 10 g kg^{-1}, malathion 5% dust with 2 doses @ 1g kg^{-1} and 1.5 g kg^{-1} as standard and 1 untreated control were used against the pest. Leaves and seeds of various indigenous plants were collected from different parts of Nagaland and *A.indica* oil cake was procured from Gauwhati, Assam. Leaf and seeds of plant products namely *Eucalyptus globulus* Labill, *Melia azedarach* Linn, *Azdirachta indica*, *Azadirachta juss*, *Zanthoxylum oxyphyllum* Edgw, *Diospyrus lanceofolia* Roxb, *Litsea citrate* Bel.vern were collected and tried for about a month. Dried materials were ground to fine powder and were kept in polythene bags labeled and sealed. Rice seeds were treated with 2 doses @ 5 g kg^{-1}, 10 g kg^{-1} (w/w). The treated seeds were filled in 1 kg capacity of plastic jars and 5 pairs of *S.cerealella* were released in each jar. The experiment was based on complete randomized design with three replications. Periodical observation on insect infestation was measured in terms of percentage for each gunny bag and plastic jars. The experimental data was analyzed statistically. Correlation coefficient (r) study was done for the infestation percentage with germination percentage of seeds and estimation on linear regression coefficient (b) for percent infestation with germination percentage was carried out.

3. Results and Discussion

3.1. *Evaluation of storage structures losses against angoumois grain moth*

The analyzed pooled data (Table 1) of two consecutive years (1998-2000) on infestation percentage of *S. cerealella* on stored paddy indicated the best result in *Ahning* with *Tsakvong* (1.00%, 2.83%) and moisture content 17.4%, 16.3% at 3 and 6 months of storage. Highest infestation (2.83%, 6.17%) with moisture content 17.4% and 16.8% was recorded in gunny bag during 3 and 6 months of storage. However, infestation was not found at the time of storage. Highest germination 93%, 96% and 89% with respective moisture content of 18.5%, 17.3% and 16.5% was recorded in *Mer* at storage time, *Ahning* with *Tsakvong* and *Telha ki*, 3 and 6 months of storage, respectively; whereas lowest value was obtained in *Chünuo* (54.50%), *Chünuo* (65.00%) both at storage and after 3 months of storage, Gunny bag (71.33%) after 6 months of storage with 19.00%, 17.3%, 16.8% moisture content, respectively (Table 2).

Ahning with *Tsakvong* had the least grain damage is made up of bamboo strips and in the middle of the grains a bamboo cone is kept for proper circulation of air, so that heat spot does not develop which might have reduced the incidence of *S. cerealella*. In similar support to this, Basunia et al. (1997) reported that rough rice stored in bamboo bin was recorded to be good in terms of temperature, moisture content and germination in comparison with those in wooden and metal bin. In the other hand, in contrast to this suggestion, some workers (Pruthi and Mohan 1950; Bordoloi, 1990) indicated that grains stored under ventilated condition had sustained higher level of infestation than stored under airtight condition.

The present finding also reported increase in infestation percentage as period of storage advanced for all storage structures. This is in conformity with the findings of Prakash et al., (1990); Bordoloi (1990) who reported on the increase

Table 1: Average of per cent infestation of *S. cerealella* in different indigenous storage structures (1998-2000)

Name of the place/district	Storage structure	At the time of storage		After 3 months of storage		After 6 months of storage	
		Moisture (%)*	Infestation (%)	Moisture (%)	Infestation (%)	Moisture (%)	Infestation (%)
Khensa, Mokokchung I	*Ahning* (Bamboo basket)	18.0	0.00[a] (0.29)	17.3	2.17[ab] (8.45)	16.5	4.33[c] (12.00)
Khensa, Mokokchung II	*Ahning* with *Tsakvong* (Bamboo basket with bamboo cone)	18.4	0.00[a] (0.29)	17.4	1.00[c] (5.74)	16.3	2.83[e] (9.68)
Jotsoma, Kohima	*Chünuo* (Bamboo basket)	19.0	0.00[a] (0.29)	17.3	1.50[bc] (6.97)	16.5	3.50[d] (10.76)
Medziphema, Dimapur I	*Telha Ki* (Wire net+bamboo)	18.6	0.00[a] (0.29)	17.2	1.33[c] (6.60)	16.5	3.17[de] (10.24)
Medziphema, Dimapur II	Gunny bag	18.6	0.00[a] (0.29)	17.4	2.83[a] (9.68)	16.8	6.17[a] (14.38)
Dimapur I	*Mer* (Made of bamboo)	18.4	0.00[a] (0.29)	17.3	2.50[a] (9.07)	16.6	5.50[ab] (13.55)
Dimapur II	Metallic drum	18.0	0.00[a] (0.29)	17.4	2.33[a] (8.74)	16.5	5.17[b] (13.14)
Zapumi, Zunheboto	*Ale* (Granary Made of bamboo)	18.1	0.00[a] (0.29)	17.1	1.50[bc] (6.97)	16.6	3.50[d] (10.78)
SEd			0.00		0.71		0.44
CD (p=0.05)			0.00		1.50		0.94

Figures in the parentheses represent angular transformed values; Means within columns separated by Duncan's multiple range test (p=0.05); Means followed by the same letter shown in superscript(s) are not significantly different.


Plate 1. Storage structures used in the study

(a) *Ahning* (bamboo basket) (b) *Ahning* with *Tsakvong* (bamboo baket with bamboo cone) (c) *Chünuo* (Bamboo basket) (d) *Telha Ki* (wire net+bamboo) (e) Gunny bag (f) *Mer* (bamboo) (g) *Ale* (Granary made of bamboo)

of infestation as the period of storage advanced from 3 to 9 months.

Average data (Table 2) of two years (1998-2000) study on the effect of storage structures in germination of paddy grains had shown the highest germination rate (93%) of rice seeds in *Mer* storage structure with a moisture content of 18.4% at the time of storage. The higher average germination percentage was found in *Ahning* with *Tsakvong* (96%) after 3 of storage and *Telha ki* (89%) after 6 months of storage, with respective moisture content of 17.4% and 16.5%. Since all the storage structures were indigenous where no such earlier investigations were carried out, the result obtained from the present study could not be brought into a conclusive discussion. Table 3 may help in understanding of the micro-climatic conditions

Table 2: Average of percent germination on the incidence of *S. cerealella* in different indigenous storage structures (1998-2000)

Name of the place /district	Storage structure	At the time of storage		After 3 months of storage		After 6 months of storage	
		Moisture (%)*	Germination (%)	Moisture (%)	Germination (%)	Moisture (%)	Germination (%)
Khensa, Mokokchung I	*Ahning* (Bamboo basket)	18.0	87.33^{b} (69.18)	17.3	92.17^{b} (73.76)	16.5	88.50^{a} (70.21)
Khensa, Mokokchung II	*Ahning* with *Tsakvong* (Bamboo basket with bamboo cone)	18.4	68.33^{c} (55.79)	17.4	96.00^{a} (78.46)	16.3	86.00^{ab} (68.11)
Jotsoma, Kohima	*Chünuo* (Bamboo basket)	19.0	54.50^{d} (47.60)	17.3	65.00^{e} (53.73)	16.5	85.00^{ab} (67.26)
Medziphema, Dimapur I	*Telha Ki* (Wire net+bamboo)	18.6	85.00^{b} (67.37)	17.2	81.50^{d} (64.53)	16.5	89.00^{a} (70.65)
Medziphema, Dimapur II	Gunny bag	18.6	86.83^{b} (68.83)	17.4	80.17^{d} (63.55)	16.8	71.33^{c} (57.64)
Dimapur I	*Mer* (Made of bamboo)	18.4	93.00^{a} (74.66)	17.3	89.17^{c} (70.80)	16.6	83.50^{b} (66.07)
Dimapur II	Metallic drum	18.0	89.83^{ab} (71.52)	17.4	89.67^{c} (71.32)	16.5	73.33^{c} (58.98)
Zapumi, Zunheboto	*Ale* (Granary made of bamboo)	18.1	70.83^{c} (57.38)	17.1	80.50^{d} (63.80)	16.6	86.50^{ab} (68.46)
SEd			3.12		1.78		71.33^{c}
CD (p=0.05)			6.60		3.77		(57.64)

Figures in the parentheses represent angular transformed values; Means within columns separated by Duncan's multiple range test (p=0.05); Means followed by the same letter shown in superscript(s) are not significantly different.

Table 3: Micro-weather parameters of the storage structures

Name of the place/district	Storage structure	Temperature °C		Relative humidity %	Rainfall mm
		Maximum temperature	Minimum temperature		
Khensa, Mokokchung I	*Ahning* (Bamboo basket)	18.44-29.60	7.55-19.25	59.00-78.50	0.00-533.80
Khensa, Mokokchung II	*Ahning* with *Tsakvong* (Bamboo basket with bamboo cone)	18.44-29.60	7.55-19.25	59.00-78.50	0.00-533.80
Jotsoma, Kohima	*Chünuo* (Bamboo basket)	19.90-25.30	7.30-19.90	43.00-86.60	0.50-403.80
Medziphema, Dimapur I	*Telha Ki* (Wire net+bamboo)	21.90-31.30	10.90-26.40	70.30-87.60	0.00-247.80
Medziphema, Dimapur II	Gunny bag	21.90-31.30	10.90-26.40	70.30-87.60	0.00-247.80
Dimapur I	*Mer* (Made of bamboo)	20.00 - 29.90	12.30 - 26.90	71.60-89.03	0.00-422.80
Dimapur II	Metallic drum	20.00 - 29.90	12.30 - 26.90	71.60-89.03	0.00-422.80
Zapumi, Zunheboto	*Ale* (Granary Made of bamboo)	No meteorological data but the temperature, humidity and rainfall is almost same with Mokokchung.			

of the different structures. This may help in correlating the infestation phenomenon.

The correlation co-efficient (r) study showed a positively correlation between grain damage due to *S. cerealella* and germination of rice seeds after 3 months of storage, whereas a highly negative significant relationship was observed at 6 months of storage in evaluation of storage structure (Table 4).

The analysis of linear regression co-efficient (b) value in storage structure had resulted positively non-significant at 3 months whereas at 6 months, a negative but highly significant result was obtained.

3.2. Potency of some plant products against angoumois grain moth

The analyzed pooled data (Table 5) of two consecutive years (1998-1999 & 1999-2000) on efficacy of 12 plant materials against *S. cerealella* of stored paddy indicated that *L. citrata* seed powder @10 g kg^{-1} was the most effective with 2.33%, 5.83% and 8.50% infestation after 2, 4 and 6 months of storage, respectively. The lowest was observed in *A. indica* oil cake at the rate 5 g kg^{-1} (6.50%) at 2 months, *Z. oxyphyllum* leaf powder at the rate 5 g kg^{-1} (11.50% and 22.17%) at 4 and 6 months of storage. Highest germination percentage was indicated in *L. citrate* seed powder at the rate 10 g kg^{-1} (48.00%) at 6 months of storage while lowest germination was found in *Z. oxyphyllum* leaf powder at the rate 5 g kg^{-1} (42.33%) which was at par with *M. azedarach* leaf powder at the rate 5 g kg^{-1} (43.50%) and Malathion at the rate 1 g kg^{-1} (42.33%). All the plant products were found to be very effective in controlling the grain moth. The highest efficacy was found with 10 g kg^{-1} of *L. citrata* (both leaf and kernel powder) with 2% infestation, next to Malathion. The best result was found with higher doses (10 g kg^{-1}) of all the treatments. The finding was in conformity with Borah (1982), who found that higher doses of neem were more effective in controlling *S. oryzae* and *S. cerealella*. The effectiveness of neem kernel powder against stored grain pests of wheat and rice for four months has been recorded by Teotia and Pandey (1978); Saradamma et al. (1977) and Dutta (1984). Results of different grain protectants indicated significantly reduced infestation of *S. cerealella* compared to the untreated control, where malathion was most effective among all. The effectiveness of *A. indica* oil cake powder used for the present studies was found to be less due to the use of commercial oil cakes. *L. citrata* kernel powder at the rate 10 g kg^{-1} exhibited statistical differences with all the treatments, during the period of study.

Higher doses (10 g kg^{-1}) were more effective than lower doses

Table 4: Correlation and linear regression of percent infestation with per cent germination at various months of storage in storage structures.

	Correlation coefficient 'r'		Correlation coefficient 'r'	
	Months of storage		Months of storage	
	3	6	3	6
1998-1999	0.149	-0.761*	2.399	-4.319*
1999-2000	0.019	-0.795*	0.27	-4.336*
Average of 1998-1999 and 1999-2000	0.103	-0.786*	1.731	-4.573*

*Significant at 5% level of significance

Table 5: Efficacy of certain plant products on the average percent infestation of *S. cerealella* and average percent germination of stored paddy (1999 and 2000)

Treatments	Doses ($g\ kg^{-1}$)	2 months		4 months		6 months	
		Inf. (%)*	Ger. (%)*	Inf. (%)*	Ger. (%)*	Inf. (%)*	Ger. (%)*
E. globulus leaf	5	3.83^{efgh} (11.29)	83.67^{ijk} (66.16)	8.83^{cde} (17.28)	74.83^{gh} (59.89)	13.50^{fg} (21.55)	43.83hijk (41.46)
powder	10	3.33^{fghi} (10.51)	85.83^{ef} (67.89)	7.83^{efg} (16.25)	75.50^{ef} (60.33)	11.50^{hij} (19.82)	46.00cd (42.71)
E. globulus seed	5	4.00^{efgh} (11.52)	86.50^{cd} (68.45)	8.83^{cde} (17.28)	74.50^{hi} (59.67)	11.83^{hi} (20.11)	44.17ghi (41.65)
powder	10	3.33^{fghi} (10.50)	87.33^{b} (69.15)	6.83^{ghijk} (15.15)	75.33^{efg} (60.22)	9.83^{klm} (18.27)	45.00f (42.13)
M. azedarach	5	5.67^{bc} (13.75)	85.00^{g} (67.21)	9.83^{c} (18.27)	73.83^{jk} (59.23)	15.50^{de} (23.18)	42.33n (40.59)
leaf powder	10	4.50^{cdef} (12.24)	86.50^{cd} (68.45)	9.50^{cd} (17.95)	74.17^{ij} (59.45)	10.83^{ijk} (19.22)	43.00lm (40.98)
M. azedarach	5	4.67^{cde} (12.36)	83.00^{l} (65.65)	7.83^{efg} (16.25)	74.67^{hi} (59.78)	17.50^{c} (24.73)	43.50jkl (41.27)
seed coat powder	10	3.83^{efgh} (11.29)	84.17^{hi} (66.55)	7.50^{fgh} (15.87)	75.33^{efg}(60.22)	11.83^{hi} (20.12)	45.17ef (42.23)
A. indica leaf	5	5.33^{bcd} (13.34)	86.33^{de} (68.30)	9.83^{c} (18.27)	73.50^{k} (59.02)	13.50^{fg} (21.55)	43.33kl (41.17)
powder	10	5.00^{cde} (12.88)	87.33^{b} (69.15)	9.50^{cd} (17.94)	75.00^{fgh} (60.00)	10.50^{jkl} (18.90)	44.67^{fg} (41.94)
A. indica oil	5	6.50^{b} (14.77)	85.50^{fg} (67.62)	8.83^{cde} (17.29)	75.33^{efg} (60.22)	12.50^{gh} (20.70)	44.33^{gh} (41.75)
cake	10	5.83^{bc} (13.96)	87.00^{bc} (68.87)	6.83^{ghijk} (15.15)	76.33^{d} (60.89)	9.83^{klm} (18.27)	44.00^{hij} (41.55)
Z. oxyphyllum	5	3.00^{hi} (9.95)	83.33^{kl} (65.91)	11.50^{b} (19.81)	73.00^{l} (58.69)	22.17^{ab} (28.09)	42.33^{n} (40.59)
leaf powder	10	2.67^{i} (9.34)	85.33^{fg} (67.48)	9.83^{c} (18.27)	73.83^{jk} (59.23)	20.83^{b} (27.15)	42.67^{mn} (40.78)
Z. oxyphyllum	5	3.33^{fghi} (10.51)	85.83^{ef} (67.89)	7.83^{efg} (16.25)	72.67^{l} (58.48)	18.83^{c} (25.72)	43.00^{lm} (40.98)
seed coat powder	10	3.17^{ghi} (10.22)	85.33^{fg} (67.48)	7.17^{ghi} (15.52)	73.50^{k} (59.02)	12.17^{h} (20.41)	43.83^{hijk} (41.46)
D. lanceafolia	5	4.33^{defg} (11.98)	85.00^{g} (67.22)	6.83^{ghijk} (15.15)	73.83^{jk} (59.23)	14.50^{ef} (22.37)	43.00^{lm} (40.98)
leaf powder	10	3.33^{fghi} (10.47)	85.83^{ef} (67.89)	6.50^{hijk} (14.77)	74.17^{ij} (59.45)	11.33^{hij} (19.67)	43.67^{ijk} (41.36)
D. lanceafolia	5	3.83^{efgh} (11.27)	83.50^{jkl} (66.04)	8.50^{def} (16.95)	74.67^{hi} (59.78)	9.50^{lmn} (17.95)	43.33^{kl} (41.17)
seed coat powder	10	3.33^{fghi} (10.51)	84.33^{h} (66.68)	7.83^{efg} (16.25)	75.67^{e} (60.44)	8.83^{mn} (17.29)	45.17^{ef} (42.23)
L. citrata leaf	5	2.67^{i} (9.36)	83.83^{hijk} (66.29)	7.00^{ghij} (15.34)	76.33^{d} (60.89)	21.83^{b} (27.85)	45.67^{de} (42.51)
powder	10	2.33^{i} (8.77)	84.33^{h} (66.68)	6.00^{jk} (14.15)	77.00^{c} (61.34)	16.17^{d} (23.70)	46.50^{bc} (42.99)
L. citrata seed	5	2.67^{i} (9.36)	86.83^{bcd} (68.72)	6.33^{ijk} (14.56)	76.50^{d} (61.00)	13.50^{fg} (21.54)	46.67^{b} (43.09)
powder	10	2.33^{i} (8.77)	87.00^{bc} (68.87)	5.83^{k} (13.97)	77.00^{c} (61.34)	8.50^{n} (16.93)	48.00^{a} (43.85)
Malathion	1	1.33^{j} (6.54)	84.00^{hij} (66.42)	2.83^{l} (9.66)	78.17^{b} (62.14)	5.17^{o} (13.14)	42.33^{n} (40.59)
	1.5	1.00^{j} (5.74)	88.00^{a} (69.73)	2.17^{m} (8.45)	80.83^{a} (64.04)	4.50^{o} (12.24)	43.00^{lm} (40.98)
Untreated control		10.50^{a} (18.90)	79.50^{m} (63.08	17.50^{a} (24.73)	60.50^{m} (51.06)	23.50^{a} (28.99)	40.50^{o} (39.52)
SEd±		0.77	0.23	0.54	0.15	0.51	0.15
CD (p=0.05)		1.54	0.46	1.09	0.31	1.02	0.29

*Values are means of three replications; Inf.: Infestation; Ger.: Germination; Figures in the parentheses represent angular transformed values; Means within columns separated by Duncan's multiple range test (p=0.05); Means followed by the same letter shown in superscript(s) are not significantly different

($5\ g\ kg^{-1}$) for controlling *S. cerealella* after 6 months of storage. The present investigations are in conformity with the findings of Dutta (1984), who reported that a higher dosage of neem fruit powder ($48\ g\ kg^{-1}$) was found to be the most effective dosage equivalent to the lowest dosage of Malathion dust ($2\ g\ kg^{-1}$) at % probability level. The intensity of infestation of *S. cerealella* in rice seeds six months after storage was recorded to be increased; moreover most of the contents were found to have increased. The present findings are in conformity with Prakash et al. (1981). They indicated that longer the storage period, higher was the insect infestation; the multiplication of *S. cerealella* increased with the increase of moisture content. The rice seed's viability was found intact and the present investigation are in conformity with Jotwani et al. (1967). They found that the seeds treated with neem kernel powder did not lose their viability. The germination of treated seeds were found to be decreased with the increase of infestation after 6 months. It was in conformity with Mookerjee (1969) who found 6.9% loss of seed germinability due to insects in stored paddy for 6 months. Narsimhan et al. (1985) also indicated 20-28% loss of viability in paddy due to *S. cerealella* after 6-9 months of storage. Again, after 6 months, fungal growth was observed and the moisture content of the treated seeds along with the control was found to have increased (15% to 16.5%). Moisture above 14% is conducive to insects and fungal activities (Khare, 1972 and Shah Jahan, 1975). Kauraw and Prakash (1980) also reported that insects in rice seeds were observed to enhance the increase of storage insects. Howe (1973) also reported that stored grain pests during infestation kill most of the seeds in bulk and thereby the translocation of moisture that takes place brought about the growth of fungi and arrested germination. Estimates on linear regression coefficient (b) for percent germination of rice seeds with infestation was carried out and found negatively non-significant for efficacy of treatments and correlation co-efficient (r) of percent germination of seeds with infestation percentage of *S. cerealella* was found negatively non-significant after 6 (six) months of storage (Table 6).

Table 6: Correlation and linear regression of per cent infestation with per cent germination at various months of storage using plant materials

Year	Correlation coefficient ‘r’			Regression coefficient ‘b’		
	Months of storage			Months of storage		
	2	4	6	2	4	6
A	-0.278	-0.826**	-0.205	-0.386	-1.214**	-0.070
B	-0.511**	-0.735**	-0.283	-0.500**	-0.915**	-0.117
C	-0.434*	-0.895**	-0.284	-0421*	-1.070**	-0.093

A=1998-1999; B=1999-2000; C= Avg. of 1998-2000; *Significant at 5% level of significance; **Significant at 1% level of significance

4. Conclusion

Indigenous plant products such as seed powder of *Litsea citrata* and *Diospyrus lanceofolia* may be carried out to bring out more effective pest management against stored grain pest. The use of ventilated storage structure made of bamboo had shown as a suitable structure for storage of paddy grains under high humid conditions of Nagaland. Therefore, a possible and desirable scientific approach in improvement of the indigenous structures may be a great weapon in competing against stored grain pest in near future.

5. References

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