MORGAN, T. D., P. BAKER, K. J. KRAMER, H. H. BASIBUYUK, and D. L. QUICKE, 2003: Metals in mandibles of stored product insects: do zinc and manganese enhance the ability of larvae to infest seeds? Journal of stored products research, **39**, 65-75.

PATTERSON, B. D., 1984: Correlation between mandibular morphology and specific diet of some desert grassland Acrididae (Orthoptera). American Midland Naturalist **111,** 296-303.

RIUDAVETS, J., SALAS, I., and M. J. PONS, 2007: Damage characteristics produced by insect pests in packaging film. Journal of Stored Products Research **43,** 564-570.

SAMWAYS, M. J., R. OSBORN, and T. L. SAUNDERS, 1997: Mandible form relative to the main food type in ladybirds (Coleoptera: Coccinellidae). Biocontrol Science and Technology **7,** 275-286.

SMITH, T. R., and J. L. CAPINERA, 2005: Mandibular morphology of some Floridian grasshoppers (Orthoptera: Acrididae). Florida Entomologist **88,** 204-207.

STEJSKAL V., KUCEROVA Z., and R. AULICKY 2014: A review of pest control strategies and damage potential of seed-infesting pests in the Czech stores. Plant Protection Science **50,** 165–173

STEJSKAL, V., HUBERT, J., AULICKY, R. and Z. KUCEROVA, 2015: Overview of present and past and pest-associated risks in stored food and feed products: European perspective. Journal of Stored Products Research **64,** 122-132.

STEJSKAL, V., BOSTLOVA M., NESVORNA M, VOLEK V., DOLEZAL, V and J. HUBERT, 2017: Comparison of the resistance of mono- and multilayer packaging films to stored-product insects in a laboratory test. Food Control **73**, (Part B) 566-573.

WEIHMANN, T., T. KLEINTEICH, S. GORB, and B. WIPFLER, 2015: Functional morphology of the mandibular apparatus in the cockroach Periplaneta americana (Blattodea, Blattidae)—A model species for omnivore insects. Arthropod Systematics & Phylogeny **73**, 477-488.

WHEATER, C. P. and M. E. G. EVANS, 1989: The mandibular forces and pressures of some predacious Coleoptera. Journal of insect physiology **35,** 815-820.

WOLFF, J. O. and S. N. GORB, 2012: Surface roughness effects on attachment ability of the spider *Philodromus dispar* (Araneae, Philodromidae). Journal of Experimental Biology **215,** 179-184.

TREMATERRA, P., SAVOLDELLI, S., 2014: Pasta preference and ability to penetrate through packaging of Sitophilus zeamais Motschulsky (Coleoptera: Dryophthoridae). Journal of Stored Products Research **59,** 126-132.

## Constraints in Grain quality management: A warehouse journey

**M. Loganathan*, U. Akash, R. Durgalakshmi, C. Anandharamakrishnan**

Indian Institute of Food Processing Technology
Thanjavur, Tamil Nadu - 613005, India
*Corresponding Author E-mail: logu@iifpt.edu.in
DOI 10.5073/jka.2018.463.025

### Abstract

India produces about 150 million tons of food grains per year. The major components of production are 47 million tonnes of wheat, 64 million tonnes of rice, and 13 million tonnes of pulses. Seasonal fluctuations in harvesting of grains impose efficient design for long term storage. Quality of grains will be retained by proper storage. Post harvest processing and storage conditions such as temperature, humidity, aeration, insect infestation, rodents, fungus, etc., at a particular geographical location influence the qualitative and quantitative losses of grains. Approximately about 10% of produce wasted during post production such as harvesting, threshing, and storage which means that about 15 million tons of grains are being washed out per year. Main intention of any government in warehousing is to offer a safe buffer stock during off-season. Knowledge about existing storage criteria creates a vision to develop new strategies. Based on this concept, a compartment in a godown of dimension 37.2m x 24.2m x 8m made of concrete and asbestos roof, with six doors and thirty-four windows was selected for the research. The stacks of dimension 6.5m x 3.9m x 6.1m with two hundred and sixty-four numbers of gunny bags filled with grains arranged above the wooden dunnage were selected for insect and chemical analysis. Temperature, humidity and aeration rate were recorded at four corners and at center of the stack and also at 26 different spots in whole godown. The influence of various factors on insect infestation in grains during storage was studied. The results will help to design an advanced scientific grain storage godown for safe storage of grains in gunny bags for longer duration.

**Keywords:** Godown, Dunnage, Insect infestation, Temperature, Humidity.

### Introduction

Agricultural products such as grains, cereals are stored for facing shortage of commodities during off-season, droughts and natural calamities. They are usually stored for 3–12 months by farmers, traders and by the public sector agencies like Food Corporation of India, the Central Warehousing Corporation, State Warehousing Corporations and State Civil Supplies Corporations which handle

about 30% of the production (TIFAC, 1996). In many developing world, post harvest losses of cereals accounts to 10-15% (Lucia and Assennato, 1994). Post harvest losses are mainly due to insect infestation which found their food and shelter and also contaminate the grains by their by-products and making them unfit for consumption resulting in qualitative as well as quantitative losses.

Tropical and humid areas are mostly prone to pest infestation on stored foods. The tropical climate of India is highly favourable for continuous survival of storage insect pests throughout the year. Insects gain access to storage area at various stages of processing of grains; during the development seeds/grains, processing in threshing yards, during transport or during storage. Major sources of infestations are old bags, storage structure, old containers, and cross over infestation (Pruthi and Singh, 1950).

Infestation of whole storage area is facilitated by movement of grains from one area to another or by active flight of insect pests as some of the adult insects are strong fliers. Monitoring the stored grain pest, by finding the insect population or infestation level in a period of time helps to understand the behaviour of insects with respect to environmental conditions. These will further help to determine the time for pesticide application and effectiveness of pest management actions. The emphasis of tropical storage pest management is thus on constraining the increase and spread of such infestations. Thus the following study was undertaken to determine the population pattern of insects with respect to tempertature and humidity in a godown.

**Materials and Methods**

A compartment in a godown of dimension 37.2m x 24.2m x 8m made of concrete and asbestos roof, located in Thanjavur, Tamil Nadu, India was selected for the research. The compartment was ventilated with six doors and thirty four windows. Paddy was stored in the gunny bags. About with two hundred and sixty four numbers of gunny bags filled with grains were arranged above the wooden dunnage. Individual stack has the dimension of 6.5m x 3.9m x 6.1m. Among them one stack was selected for studying the population behavior of insects. The temperature and humidity were recorded using HOBO data logger at points near the ventilation and far from ventilation from 10.00 am to 4.00 pm at an interval of 2 hours. Simultaneously, insect population at the top, middle and bottom of the stack was also counted. The study was conducted during the post monsson season (December) with an average outdoor temperature of 25° C. Based on the readings, the population pattern of insects with respect to temperature, humidity and time was investigated.

**Results**

The results of the study showed that temperature was found maximum in the interior part of compartment while ventilated areas near door and windows recoreded minimum temperature. The humidity was found to be higher in ventilated areas than interior part. It was observed that five fold increase in insect population at the top of stack during day time and about seven fold increase in insect population after 4.00 pm.

During storage, the paddy was attacked by many insects including the *Sitotroga cerealella,, Rhyzopertha dominica, Tribolium castaneum, Sitophilus oryzae,* etc., But the major pest was identified as *Tribolium* sp., which feeds on broken grains resulted in dust formation. Similarly Rajan *et al*. (2018) explained that the most abundant species caught was *T. castaneum* across all of the localities sampled. Infested grains emitted sour and pungent smell, which was due to some secretions of beetles.

**Discussion**

The observation on the insect population or infestation level in a period of time along with temperature and humidity helps to understand the behaviour of insects with respect to environmental conditions. In general, the minimum temperature threshold for *T. castaneum* flight initiation in the laboratory being 25° C (Cox *et al.,* 2007). The results of the present study showed that temperature was found maximum in the interior part of compartment while ventilated areas

near door and windows recoreded minimum temperature. The humidity was found to be higher in ventilated areas than interior part.

**Tab. 1** Population strength of insects with respect to temperature, humidity and time

| Time | Temperature (ºC) | | Relative Humidity (%) | | Insect Count at $T_1$ | | | Insect count at $T_{avg}$ | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $T_1$ | $T_{avg}$ | $T_1$ | $T_{avg}$ | B | M | U | B | M | U |
| 10.00 am | 25.8±0.5 | 26.8±0.7 | 73.4±3.3 | 73.2±2.2 | 1±0 | 2±1 | 2±1 | 1±0 | 1±1 | 4±1 |
| 12.00 noon | 26.7±0.2 | 27.8±2.0 | 72.5±3.3 | 69.9±2.3 | 1±1 | 0±1 | 4±2 | 1±1 | 0±1 | 6±3 |
| 2.00 pm | 26.7±0.3 | 28.9±1.0 | 70.9±3.8 | 68.0±5.0 | 2±1 | 2±2 | 9±3 | 1±2 | 3±3 | 13±7 |
| 4.00 pm | 27.0±0.5 | 28.5±0.9 | 70.0±3.9 | 68.5±5.0 | 5±3 | 6±3 | 14±4 | 2±2 | 4±1 | 17±11 |

$T_1$ – Near the ventilation area; $T_{avg}$ – Far from ventilation; B – Bottom of stack; M – Middle of stack; U – Upper portion of stock

It was observed that five fold increase in insect population at the top of stack during day time and about seven fold increase in insect population after 4.00 pm. The results are in line with the report of Rajan *et al.* (2018) who reported that vast numbers of *T. castaneum* take flight inside godowns in the late afternoon. The resutls of the present study will help to design an advanced scientific grain storage godown for safe storage of grains in gunny bags for longer duration. It will also help develop effective management tactics to reduce the severity of infestations caused by stored product insects.

### 5. Future Progress

Effect of temperature, humidity and ventilation on insect population was studied for short duration. To establish the efficient pest management practices, the influence of all the above said factors on microbial growth and chemical analysis has to be studied. Further pest management by integrating the different methods based on the results of the study in large scale godown has to be studied.

### References

TIFAC (Technology Information, Forecasting and Assessment Council), 1996. Agro-Food Processing: Technology Vision 2020. Cereals: Current Status and Vision. Department of Science and Technology, New Delhi.

Lucia, M. D., and Assennato, D., 1994: Agricultural engineering in development—post-harvest operations and management of foodgrains. - In FAO Agricultural Services Bulletin. Food and Agricultural Organization of the United Nations.

Pruthi, H.S., and M. Singh, 1950: Pests of stored grain and their control - Special number. -Indian Journal of Agricultural Science 18:1-52.

Cox, P. D., Wakefield, M.E. and T.A. Jacob, 2007. The effects of temperature on flight initiation in a range of moths, beetles and parasitoids associated with stored products. Journal of Stored Products Research 43: 111-117.

Sonai Rajan, T., V. Muralitharan, G.J. Daglish, S. Mohankumar, M.A. Rafter, S. Chandrasekaran, S. Mohan, D. Vimal, Chitra Srivastava, M. Loganathan, G.H. Walter, 2018. Flight of three major insect pests of stored grain in the monsoonal tropics of India, by latitude, season and habitat. - Journal of Stored Products Research 76: 43-50.

## Modelling of population dynamics of insects in any ecosystem with several distributions of insect development: A Review

**Fuji Jian [1]*, Digvir S. Jayas [1], Paul G. Fields [2], Noel D.G. White [2]**

[1] Department of Biosystems Engineering, University of Manitoba, Winnipeg, MB, R3T 5V6 Canada.
[2] Morden Research and Development Centre, Agriculture and Agri-Food Canada, c/o: Department of Biosystems Engineering, University of Manitoba, Winnipeg, MB, R3T 5V6 Canada.
*Corresponding authour, Email: Fuji.Jian@umanitoba.ca
DOI 10.5073/jka.2018.463.026

### Abstract

Predicting the occurrence of insects with a high accuracy requires the estimation of insect development time and the variation among individuals for each life stage and species under different environmental conditions such as fluctuating temperature, variation of relative humidity, different body sizes and stages of the insects, levels of crowding, and food supply. This review summarized the modeling methods of population dynamics of