Ethnic storage strategies adopted by farmers of Tirunelveli district of Tamil Nadu, Southern Peninsular India

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Proper storage of grains is essential to prevent infestation by stored product pests. Stored product pest management techniques followed by peasants are worth emulating. A detailed survey of stored product pest management strategies followed by the people of Tirunelveli district of Tamil Nadu was done. The farmers have been protected their stored product using biological and physicochemical methods. The present study identified the use of 11 plant species (belonging to 6 families) against stored grain pests. The methods and materials used for stored product pest management are enumerated in this communication.

Key words: Ethnic storage strategies, Medicinal plants, Pest management strategies

Introduction

Agriculture is the major occupation of the people all over the world. More than 70% of Indian population depends on agriculture for their livelihood (Chandrasekar *et al*., 2005; Jeeva *et al*., 2006a; Kiruba *et al*., 2006a). The success of agricultural operations depends on effective storage of food grains. The different agencies that lead to grain loss, insect pests inflict enormous losses to valuable agricultural produce. Even though chemical control of stored product pest is predominant in the organized sector, traditional pest control practices are still continued especially in remote areas. Safe and efficient stored product pest management are essential to protect the grains from infestation by insects and other agencies (Kiruba *et al*., 2006b; Kiruba *et al*., 2007).

Food grains are being spoiled after harvest due to lack of sufficient storage and processing facilities (Singh and Satapathy, 2003). The annual losses in stored product has been given as 10 percent of all stored grain- about 13 million tons of

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grain loss due to insects alone (Wolpert, 1966). Damage by fungi and sprouting causes economic loss to the tune of hundreds of millions of dollars to grain producers, merchandisers, and processors each year (Harein and Meronuck, 1995). Management of stored product pest through fumigation (Page and Lubatti, 1963), chemical pesticides (Lemon, 1967) and plant-based deterrents (Schmutterer, 1990) saves only a portion of the product from damage.

Farm folk of the tropics and subtropics mainly follow traditional storage methods. Though these methods have a strong scientific basis, it is seldom known to the users. Most of the traditional methods, at least unawares, minimize economic loss and damage to the environment.

People of Tirunelveli district, Tamil Nadu, India, follow time-tested customs and practices in various areas like food, medicines and agriculture. In recent years, documenting of traditional wisdom gained significant attention world over, because of its importance in developing high potential, environment friendly and sustainable management. Identification and utilization of such indigenous knowledge from the elderly people from rural and tribal belts will surely bridge the gap between the current scientific and age-old practices (Sarkar and Maitra, 2001; Jeeva and Anusuya, 2005; Jeeva *et al*., 2005; Jeeva *et al*., 2006b). The aim of the present investigation was to study the strategies followed by the people of Tirunelveli area for preserving stored products.

Study Area and Climate

Tirunelveli the penultimate southern most district of Tamil Nadu, is described as a microcosm of the State, owing to its mosaic and diverse geographical and physical features such as lofty mountains and low plains, sand dunes, rivers and cascades, seacoast and thick inland forest, sandy soils and fertile alluvium, a variety of flora, fauna, and protected wild life. The Tirunelveli District is located between 08^{o} 8' and 09^{o} 23' latitude and 77^{o} 09' and 77^{o} 54' longitude. The total geographical area of the district is 6,823 sq. Km. The State of Kerala, Gulf of Mannar and the districts of Virudhunagar, Thoothukudi and Kanyakumari surround the district (Kiruba *et al*., 2006c; NIC, 2007).

Materials and methods

The present study was conducted from June, 2003 to December, 2004 in Tirunelveli district and information about the prevalent stored product pest management strategies were obtained from farmers through direct interviews. Plants specimens used in pest management practices were collected and identified with the help of regional and local flora (Gamble and Fisher, 1957;

Mathew, 1981; 1982; 1991; 1993) and also by referring them to the herbarium of Botany Department, Scott Christian College, Nagercoil. The insect pests were identified with the help of voucher specimen available in the Department of Zoology, Scott Christian College, Nagercoil. The grains and other products stored in the different facilities were examined to ascertain their quality and pest infestation status.

Results and Discussion

The traditional stored product pest management strategies of the farmers of Tirunelveli District may be conveniently classified as (i) biological methods and (ii) physicochemical methods.

Biological methods

The farmers have been used plant products for biological control of stored grain pests. The plant used belong to 6 families, 10 genera and 11 species. Fabaceae is the dominant family, with 4 species, followed by Myrtaceae and Poaceae 2 species each, whereas Annonaceae, Meliaceae and Verbenaceae, one species each, were being used against stored grain pests by the farmers of Tirunelveli district (Table 1).

The leaves of *Azadirachta indica* and *Pongamia glabra* are used for controlling pests in rice e.g. *Sitophilus oryzae, Tribolium castaneum, Corcyra cephalonica* and *Sitotroga* sp.. Leaves of *A. indica, P. glabra* and *Vitex negundo* have been used to manage the pest in maize e.g. *S. oryzae, T. castaneum* and, *C. cephalonica*. The leaves of *Annona squamosa*, *A. indica*, *Cymbopogon citratus, C. nardus, Erythrina indica* and *E. variegata* have been used for The effective management of pests in pulses e.g. *Vigna unguiculata*, *V. mungo* and *V. radiata*.

The plants used by farmers have already been reported to possess active components against insect pests. Srivastava *et al*. (1988) have reported that 0.2 percent (v/w) ginger grass oil on red gram prevented oviposition and F_1 emergence of *Callosobruchus chinensis* (L) for a long period after initial release of adults. Rehm and Espig (1991) established the high geraniol content of ginger grass oil. Paranagama *et al*. (2003a) reported that damage to grain was lower in *C. citratus* Stapf and *C. nardus* Rendle treated to *Oryza sativa* than in the control. *C. citratus and C. nardus* showed deleterious effects on oviposition and F1 adult emergence of cow-pea bruchid, *C. maculatus* (F) compared to the control during no-choice tests (Paranagama *et al*., 2003b).

Table 1. Plants used against stored grain pests in Tirunelveli district.

Botanical Name	Family	English Name	Tamil Name
Annona squamosa L.	Annonaceae	Custard apple	Pangiee
Azadirachta indica A.Juss.	Meliaceae	Neem	Vembu
Cymbopogon citratus Stapf.	Poaceae	Lemon grass	Seemai madahalai
Cympopogn nardus Rendl.	Poaceae	Malabar lemon grass	Chukkunaripul
Erythrina indica L.	Fabaceae	Indian coral	Mullu murungai
Erythrina variegata L.	Fabaceae	Indian coral	Mullu murungai
Eucalyptus globulus Labill.	Myrtaceae	Blue gum	Eucali
Pongamia glabra Vent	Fabaceae	Indian beach	Pungam
Psidium guajava L.	Myrtaceae	Guava	Koyya
Tephrosia purpurea Pers.	Fabaceae	Wild indigo	Kolingi
Vitex negundo L.	Verbenaceae	Negundo	Nochi

Storage structures are usually filled with dried leaves of *P. glabra* and *A. indica*. The pesticidal activity and insect deterrent action of *A. indica* and *P. glabra* had been well documented and the leaves of these two plants contain various bioactive compounds (Jilani and Su, 1983). *A. indica* leaves applied to a filter paper produced a repellency of 42 percent against *T. castaneum* (Herbst) eight weeks after treatment, compared with 81.5 percent repellency, one week after treatment. Babu *et al*. (1989) reported the inhibitory action of *P. glabra* seed oil- 0.75 percent (v/w) - on adult emergence of *C. chinensis* in pigeon pea. Dunkel *et al*. (1991) showed that the extract of *A. indica* seeds (0.2 percent w/w) applied to wheat caused 50 percent mortality in adult *S. oryzae* (L.) and 15 percent mortality in *Rhyzopertha dominica* (Fabricius) within three days and F_1 emergence was reduced by 98 and 94 percent respectively. Khaire *et al*. (1992) reported *P. glabra* seed oil (5 ml/kg) applied to wheat held in a store for 12 months prevented natural infestations by insects.

A. squamosa and *E. globulus* have proved insecticidal activity against stored product pests. Kotkar *et al*. (2001) isolated flavonoids from aqueous extracts of *A. squamosa* which showed 80% insecticidal activity against *C. chinensis* at a concentration of 0.07 mg/ml. Patel and Patel (2002) reported that a mixture of *A. indica* and *E. globulus* leaf powder in mustard oil gave highly effective against *C. cephalonica* (Stainton) on stored rice. Acetone and petroleum extracts of *A. squamosa* leaves exhibited 12.5 and 5.0% reduction in oviposition of *C. cephalonica* respectively, (Dwivedi and Pareek, 2002).

E. indica and *E. variegata* bark peelings are used as padding in certain storage bins. Ito (1999) isolated five oxy-erythrinan alkaloids with insecticidal properties, erythrinine, 11- hydroxyerysotrine, erysotramidine, erytharbine, crystamidine and a dibenz {d,f} azonine type alkaloid, erybidine, from

Erythrina plants. Tanaka *et al*. (2000) isolated two new isoflavanoids, eryvarin A and eryvarin B from the wood of *E. variegata*.

P. guajava and *V. negundo* leaves admixed with freshly harvested paddy, field infested with *Sitotroga cerealella* (Oliver), significantly reduced the number of emerging F1 adults during four months of storage (Dakshinamurthy 1988). The LD_{50} for *P. guajava* leaf powder admixed with rice assessed for *S. oryzae* and *S. granarius* at seven days was 2.25 percent and 2.28 percent (w/w), which prevented the production of F_1 adults of both species (Sharaby, 1989). Morallo-Rejesus *et al*. (1990) showed that leaves of *V. negundo* caused 80 percent mortality in adult *C. chinensis* within 48 h and prevented egg laying in mung bean. Prakash *et al*. (1990) showed that Z-heptatriacontanone isolated from the leaves of *V. negundo,* when admixed with rice at 400 mg per Kg reduced oviposition in *S. cerealella, R. dominica* and *S. oryzae*. The legume tephrosia (*Tephrosia purpurea*) contains insecticidal properties and an antitumor compound, lupeol (Beckstrom-sternberg and Duke, 1994).

Physicochemical methods

The following physicochemical methods were recorded during the present study such as sun drying before storing the grains and application of fly ashes and diatomaceous soil (Table 2).

Solarization is the common practice followed by the farmers before storing the grains and pulses. The solarization time is varied based on the products and they chew the grains to confirm whether dried. Farmers also used free soil and ashes for long term storage of pulses for seed purpose.

The stored grains are sun dried by the farmers and killed the most infestive agents. Lale (1998) reported that occurring decreased oviposition and increased adult mortality of *C.* maculatus in grains stored after exposure to sun. Lale and Vidal (2000) recorded 100 percent mortality of the eggs and first instar larvae of *C. maculatus* and first instar larvae of *C. subinnotatus* (Pic) exposed to sunlight for 2 h in *V. subterranean* (L). Exposure of *C. maculatus* and *C. subinnotatus* adults to solar heat decreases the oviposition, retard egg development and reduce survival rate of immature stages. At a temperature of 50°C, both species laid significantly fewer eggs with lower hatching potential, than those maintained at 40ºC. In both the species, no adult progeny emerged from seeds harbouring first instar larvae, when exposed to a temperature of 50ºC for 2,4 or 6 h (Lale and Vidal, 2003). Exposure to the sun in different coloured polyethylene bags for 24 h killed the eggs of *C. chinensis* and grubs found in infested green gram. Complete egg mortality was recorded in coloured bags and complete grub mortality, only in black coloured bags (Singh and Sharma, 2003).

Table 2. Traditional management of pest in stored products - Tirunelveli District.

Products	Storage Structure	Pests	Management	
			Biological	Physico-chemical
Rice (*Oryza sativa*)	Mankattai (Mud House) Kulukkai (Earthen Bin)	*S. oryzae* *T. castaneum* *C. cephalonica* *S. cerealata* *R. dominica*	*A. indica* *P. glabra*	Solarization
Maize (*Zea mays*)	Vattapetti (Palmyra leaf bin)	*S. oryzae* *T. castaneum* *C. cephalonica* *R. dominica*	*A. indica* *P. glabra* *V. negundo*	Solarization
Pulses (*Vigna unguiculata*) (*V. mungo*) (*V. radiata*)	Adukkupanai (Earthen Pot) Kulukkai (Earthen Bin)	*C. maculatus* *C. chinensis* *S. oryzae* *T. castaneum*	*A. indica* *P. glabra* *C. citratus* *C. nardus* *A. squamosa* *V. negundo* *E. indica* *E. variegate* *E. globules* *T. purpurea* *P. guajava*	Solarization Ashing Soil top uping and mixing

The stored product is topped up by dry sifted red soil, which does not allow any infestation to the grains stored underneath. Normally the red soil layer is about 2 to 3 cm thick. Diatomitzed dust served as a protectant when applied to maize stored in bags (Narayanaswamy, 2002). Such mineral dusts scratch the thin waterproofing layer of wax, which exists on the outside surface of the insect cuticle, allowing loss of water leading to the death as a result of desiccation.

Occasionally grains were mixed with fly ash and stored. Hall (1970) reported the admixture of wood ash or sand with food grains in many areas, usually restricted to the storage of small quantities for seed purposes. Hakbijl (2002) reported the use of ash from burnt cow dung as an insecticide against *T. castaneum*, *S. granarius* and *Cryptolestes ferrugineus* larvae. The insect pests were killed by desiccation or by packing the inter granular spaces, restricting insect movement and emergence.

Conclusion

The use of` commonly available plant materials and other products help to reduce the huge financial inputs associated with chemical pesticides. Thus, the grain storage strategies are adopted by the indigenous community leading to economize and effective against pests. They further prevent pollution of the environment, rendering the products pesticide – free and quite safe for human consumption.

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