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Research on Different Fumigation Methods for Controlling Booklice (Psocids)

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Abstract: The authors performed warehouse experiments to evaluate four models: recirculation fumigation, routine fumigation, routine fumigation combined with protectant and single-purpose protectant to control booklice in High Flat Warehouses and Arched Slab Warehouses. The results show that routine fumigation combined with protectant can maintain the density of booklice below 50/kg over 12 months and is a relatively effective method to control booklice.

Key words: booklice, recirculation fumigation, routine fumigation, protectant

Introduction

At present, a severe problem that grain stored faces in state warehouses is rampant booklice (psocids). Booklice not only result in the loss of grain storage, but also their remains and excrement give out a foul smell, which contaminates grain storage and environment. All along, people have been paying more attention to insect control of relatively bigger insects such as the grain moth, *Sitophilus zeamais* Motsch., ignoring booklice. However, because of short growing period and fast reproduction of booklice, it has become one of pervasive insects all over the country. Meanwhile, because of its small body, ease of escaping, parthenogenesis, PH₃ resistance etc., booklice control has become a spiny problem in the work of insect control of grain storage.

In 2006, in order to investigate new approaches to booklice control, we cooperated with Hunan Dong'an State Grain Reserve Ware

house to develop recirculation fumigation, routine fumigation, routine fumigation plus protectant and single-purpose protectant as four experimental methods to control booklice in High Flat Warehouses and Arched Slab Warehouses.

1 Materials and Methods

1.1 Facilities and Materials

1.1.1 Experimental warehouse type Arched Slab Warehouse and High Flat Warehouse.

1.1.2 Experimental seeds Early Indica Rice, Medium Indica Rice, Late Indica Rice.

1.1.3 Experimental facilities grain grading sifter, wooden rake, equipment for recirculation fumigation.

1.2 Experiment Handling

Basic situation of experimental warehouse, handling method, using dosage etc., (see Table 1 below)

Table 1. Experimental warehouse type, dosage and grain type

Type and No.	Arched slab warehouse (area 600m ²)			High flat warehouse (area 600m ²)			
	104-01	104-02	103-01	110-02	108-02	107-01	106-02
Handling agent	Shushiling + routine fumigation	Shushiling	Routine fumigation	Shushiling + routine fumigation	Routine fumigation	Shushiling	Recirculation fumigation
AIP dosage	30kg		50kg	20 kg	30 kg		20 kg
Protectant dosage	60 kg	60kg		40kg		40kg	
Grain storage types	Medium Indica Rice	Medium Indica Rice	Medium Indica Rice	Late Indica Rice	Late Indica Rice	Early Indica Rice	Late Indica Rice
Reserves (t)	1499	1505	1501	2130	2128	2137	2122
Year	2004	2005	2004	2004	2005	2005	2005
Water (%)	12.3	12.4	12.2	12.4	13.5	12.6	12.5

Type and No.	Arched slab warehouse(area 600m ²)			High flat warehouse(area 600m ²)			
	104 -01	104 -02	103 -01	110 -02	108 -02	107 -01	106 -02
mixture (%)	0.6	0.7	0.7	0.7	0.7	0.7	0.8

1.3 Experimental Agents

1.3.1 Shushiling powder(3%) made by Hunan Cereals and Oils Science Research & Design Institute

1.3.2 Aluminium phosphide (AIP) AIP tablet(56%) made in Shenyang.

1.4 Method for Using Agent

1.4.1 Shushiling powder(3%) handling

Investigating population density before using dosage and selecting D1.00mm grain grading sifter, the experimenters powder the surface of grain with 75% Shushiling powder. After powder falls on the surface of grain, drag wooden rake back and forth on the surface of grain so that the chemical agent can be turned into the grain layer 15cm to 30cm; then cover the surface of grain with 25% remaining powder and turn the surface over by using a wooden rate; More dosage should be used on the surface of grain near the gate of warehouse and 1.0m away from the wall.

1.4.2 Recirculation fumigation

Referring to *New Grain Storage Technology* to process recirculation fumigation of phosphine

1.4.3 Routine fumigation

Referring to *Standard of Cereals and Oils Storage Technology* to process fumigation by adopting the method of spraying dosage on the surface

1.5 Investigating Population Density

On April 20, based on the booklice situation in the previous year, the experimenters selected five sample places in the severe part of the booklice population. Sampling amount is not less than 2kg in each sample. Population density is checked by using a grain grading sifter. After applying pesticides, population density should be checked throughout the fixed period.

2 Results and Analysis

2.1 The Four Handling Methods for the Efficiency of Booklice control in High flat Warehouse

Table 2. The four handling methods for the efficiency of booklice control in high flat warehouse

investigating time	Warehouse No. and handling methods			
	107 -01	108 -02	106 -02	110 -02
	Shushiling	Routine fumigation	Recirculation fumigation	Shushiling + Routine fumigation
4.20	25	13	10	26
4.21	Application using dosage			Application using dosage
5.20	2	32	35	3
6.20	1	45	40	1
7.09	5	70	60	4
7.17	7	fumigation	fumigation	6
7.26	10			10
7.31	8	close	close	8
8.10	26			6
8.18	35	ventilation	ventilation	18
8.30	45	0	0	fumigation
9.07	40	8	2	close
9.14	65	17	5	
9.22	80	35	10	ventilation
9.29	200	50	15	0
10.07	300	90	47	0
10.23	innumerable	200	78	0
11.10	innumerable	innumerable	160	0
11.21	innumerable	innumerable	300	0

According to Table 2, after only using Shushiling powder (3%) in warehouse 107 - 01, booklice population density dramatically decreased from 25/kg on April 20 to 1/kg on June 20 and low-population density lasted for nearly three months. It didn't begin to increase until the early of August. By the end of September, because of high grain temperature and humidity, booklice reproduced very quickly. The experiment shows that Shushiling has sound efficiency for booklice control and that the control period amounts to five months, but it can't thoroughly disinfest booklice.

In experimental warehouses 108 - 02 and 106 - 02, protectant of grain storage was not used. With the increasingly high temperature and grain humidity, booklice production and reproduction became very fast, activity was frequent, which caused population density to become large. Therefore, on July 17 fumigation of phosphine had to proceed. After ventilating on August 18, without the efficient control of the protectant, booklice activity became rampant again in two experimental warehouses, and moreover the speed rapidly increased and surpassed the prevention and control level. Considering the cost of prevention and control and machinery ventilation to be processed, grain file handling was not implemented.

In warehouse 110 - 02, firstly we used Shushiling of grain storage protectant and then combined ALP routine fumigation to control booklice, whose population density basically kept below 50/kg throughout 10 months. The control indicator had not been reached (control

indicator decided internally by China grain reserves corporation).

Therefore, we concluded that routine fumigation plus protectant has quite outstanding efficiency for prevention and control of booklice in the high flat warehouse.

2.2 Three Handling Methods for the Efficiency of the Prevention and Control of Booklice in Arched slab Warehouse

According to Table 3, in experimental warehouse 104 - 02, on April 21 after using only Shushiling powder (3%), booklice were efficiently controlled. By the end of August booklice density was basically controlled under 50/kg. But in September population density dramatically increased and rapidly reached the range of prevention and control. Therefore, in order to efficiently control booklice to produce, 30 kg of Shushiling powder (3%) had to be added.

As for experimental warehouse 103 - 01, without using grain storage protectant and with the increasing temperature and grain temperature, booklice production and reproduction became fast, which caused population density to increase rapidly. On July 31, fumigation of phosphine was required to control and prevent booklice. After ventilating on August 18, without the efficient control of grain storage protectant booklice reproduced very quickly and rapidly reached the range of prevention and control. In addition to this, because grain moth, *Sitophilus zeamais* Motsch. and other main insects were rampant, a second fumigation was initiated on October 23.

Table 3. Three methods for the efficiency of the prevention and control of booklice in arched slab warehouse (unit: insect/kg)

Investigating time	Warehouse No. and handling methods		
	104 - 01 Shushiling + Routine fumigation	104 - 02 Shushiling	103 - 01 Routine fumigation
4. 20	19	15	11
4. 21	using dosage	using dosage	
5. 20	9	10	30
6. 20	7	8	50
6. 30	10	20	70
7. 09	15	5	120
7. 17	20	8	140
7. 26	40	10	280
7. 31	40	15	fumigation
8. 10	48	30	sealed
8. 18	fumigation	45	ventilation

Investigating time	Warehouse No. and handling methods		
	104 - 01	104 - 02	103 - 01
	Shushiling + Routine fumigation	Shushiling	Routine fumigation
8.30	close	40	10
9.07	ventilation	80	15
9.14	0	100	20
9.22	0	200	20
9.29	0	using dosage	25
10.7	0	35	70
10.23	0	14	fumigation
11.10	0	9	close
11.21	0	10	ventilation

In experimental warehouse 104 - 01, we adopted the method of fumigation combined with protectant so that booklice population density could be kept low throughout the storage period.

Therefore, we conclude that fumigation combined with protectant has good effects to control the production and reproduction of booklice in arched slab warehouse.

3 Conclusion and Discussion

3.1 Because PH_3 has sound penetrating ability, routine fumigation and recirculation fumigation can achieve a high one-off killing rate. Recirculatory fumigation is better than routine fumigation.

However, each fumigation method has the disadvantage of a short control period so that booklice recurs very quickly after ventilating.

3.2 Grain storage protectant of Shushil-

ing, with a long control period over five months, is relatively effective for booklice control. Because it functions as a contact and stomach poison, booklice in deeper layer can not be killed or thoroughly destroyed.

3.3 Fumigation combined with protectant can give full play to the strong penetrating ability of PH_3 , which thoroughly kills pests, coupled with the long control period feature of protectant. The result is that production and reproduction of booklice can be efficiently controlled to ensure booklice density, over a year, remains less than 50/kg a year (control indicator decided internally by China Grain Reserves Corporation).

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