Study on Application of prevention of stored grain pests based on new integrated type of trap forecasting

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Abstract

A new integrated type of trap based on light, hormone, food luring, and crawling and seam digging habits of insects is researched and developed. Trapping effects of artificial screening methods and new traps are compared in experiments, and the effectiveness of the new trap is determined. The results show that: the new trap's trapping and artificial screening methods have similar trends; the new trap has significant trapping effect, for example, when manual screening method detects a population density of *Cryptolestes ferrugineus* it is 45/kg, pests trapped by 5 traps in 7 days are 1722g/warehouse (per gram of *Cryptolestes ferrugineus* about 6791~7142 insects); this new integrated-type of trap has good trapping, capturing, and forecasting capabilities in the applications in grain piles, empty warehouses and outside warehouses.

Keywords: trapping, capturing, forecasting, integrated type of trap, artificial screening method

1. Introduction

The use of light in the control of pests has a long history. Records dating back to the Tang Dynasty (DATE) indicate fires were lit at night to attract and control locusts. In the 1950s, our country carried out the forecast and prediction of field pests by use of black light lamps and continued into the 1970s, wherein large-scale application of black light lamps to control field pests emerged. Some advanced countries such as the United States began the application of lamplight traps to control field cotton bollworm in 1860 (Wu et al., 2009). In the past few years, control of insects based on their habits towards light, color and pheromone has been done (Zhang et al., 2004, Li et al., 2008, Wu et al., 2009, Zhou et al., 2011, Liu, 2012), however, it is acknowledged that studies and reports on pest-killing by such an approach in warehouses are sparse (Xiong et al., 2004, Yao et al., 2005, Zhu et al., 2005, Song et al., 2008, Wang Zhengyan, 2010). Light-attracting lamps can capture over 1500 varieties of pests, among which, there are 100 species of over 20 genus involving in stored grain pests including Lepidoptera and Coleoptera. Especially in recent years, long-term sole reliance on aluminum phosphide led to ineffective fumigation in some warehouses, which resulted in resistance of *cryptolestes ferrugineus* and consequently increasing difficulty in control (Li et al., 2009, Li et al., 2011, Su et al., 2013). *Cryptolestes ferrugineus* is a commonly found in stored grain and is a secondary feeder. It can cluster in the surface layer of grains with moist dust and larger impurities, It is attracted to light (Qi et al., 2013). Therefore, the purpose of this test is to new trap to provide another available technology for stored grain pest management.

2. Materials and Methods

2.1. Structure of comprehensive trap

The trap is comprised of the following components; lampshade, pest-attracting modulator tube, light guide ball, fan, pest collecting bag, support, chassis and power supply control board. Electric light sources applied to observation and predication for the present mainly cover of incandescent light bulbs, mercury lamps and LED lamps. Incandescent light bulbs have a high energy consumption, low efficiency and emission of visible light only. LED lamps are deficient because of thin spectrum, low volatility of light source, low varieties of pests captured and prohibitive price. Therefore, a mercury lamp (15W fluorescent lamp) was selected as the attracting light source for this test, rationale for this was test was to choose 15W features characteristics of mature technology, high pest-attracting efficiency, wide spectral region and fine energy conservation effects. Four annular modulator tubes are chosen. *Cryptolestes ferrugineus* has been shown to be sensitive to such wave lengths.

2.2. Food attractant, color, and pheromones

Food attracting dishes with covers can be placed in the trap base. One or two drops of a sex pheromone or volatile essence can be added to the food. A yellow plastic ball is positioned in the middle of the annular modulator tube for the purpose of adding volatility of lights and luminesce near the lamp so that pests can pursue light easily.

Negative pressure fan-suction collection with its power at 3W is used.

2.3. Warehouse and grain storage

East-to-west warehouses No. 22, 46, 47 (for grains collected in late July, 2014), 51 and 9 (empty warehouse) with brick-concrete structure arch bar, 30 meters in length, 18 meters in width, 7 meters in eave height, 5 meters in height of grain bulk and 1966 T in designing capacity, were chosen as test warehouses. Basic profile of the tested storage grain is specified in Table 1.

Table 1 Basic index of grain in experiment storage.

Storage No.	Variety	Quantity (T)	Stockpiling means	Storage timing	Moisture (%)	Impurity (%)	Unpolished rice yield of paddy or test weight (%)
22	rice	1474	Scattered storage	2011.10	12.2	0.6	77.9
51	rice	1617	Scattered storage	2011.11	12.3	0.6	78.0
46	wheat	1678	Scattered storage	2011.8	10.4	0.5	782
47	wheat	1927	Scattered storage	2013.7	9.6	0.4	812

2.4. Observation spot and set-up of sample collection spots

Twelve representative observation spots are chosen in the space of the warehouse, each spot covers one square meter. As is specified in Figure 1, the grain bulk has 22 pest-screening spots with each attempting to screen one kilo.

Figure 1 Layout of trapping devices and pest-test spots.

2.5. Experimental methods

Lamps were hung at around 1 to 1.5 meters above the ground in the center of the grain warehouse with a fire blanket (used for safety protection and collection of pests falling after bumping against the bulb wall) covering one square meter paved below the lamp. These lamps were also hung at around 3 meters above the ground in empty warehouses and places outside the warehouse. After sweeping clean all grain pests in the space and on the thin film of grain surface, the sealing film was unveiled. Five trapping devices were placed following plum blossom states on the grain surface (around 550 square meters), each hanging respectively in the paces four meters away from four corners and in the center of the grain pile that is around 1 to 1.5 meters from the grain pile surface. A fire blanket covering one square meter is paved below the lamps. For those with one trap only, the device is suspended in the middle of the warehouse. For pest hazard mainly occurring in the depth of 0 to 30 cm from the surface, grain surface was stirred by raking every two to three days in order to increase pest-attracting quantity.

Light hours were classified as follows: for forecasting density of grain pests (when population density is low), the most sensitive hours cover 17:00 – 24:00; for reducing density of pests in grain bulk, light should be switched open all day long, but darkness in the warehouse should be maintained in case of light leak from doors and windows. At 3:00 p.m. every day, pests in the pest-collecting bag were collected, weighed and recorded.

3. Results and Discussion

After several trials, 3W negative pressure fan suction collection method was proposed. By referring to comprehensive attraction such as sensitivity towards light, color, taste and so on of grain pests, pests that fly to the negative pressure zone formed due to rotation of fans are rapidly indrawn to the high-density pest-screening bag set at the bottom of the fan.

Table 2 Experimental conditions in the warehouse

Warehouse Number	Average Weekly Warehouse Temperature (°C)	Average of Temperature of Grain in the Upper Layer (°C)	Highest Density (pests/kg)	Number of lights	Light-up hours (h)	Trapping and killing quantity (g)
22	28.7	24.9	45	5	7×24	1722
51	28.3	24.7	31	1	4×24	656
46	28.8	24.3	22	1	7×24	447
47	29.6	31.5	None	1	1×7	48 pieces
22	27.2	24.3	38	5	7×24	1421
51	26.8	23.9	26	1	7×24	541
46	26.3	23.5	16	1	7×24	464
47	27.8	31.2	None	1	7×7	0
22	24.3	23.0	27	5	7×24	857
51	23.7	21.8	17	1	7×24	312
46	25.3	22.4	12	1	7×24	206
47	26.8	29.3	None	1	7×7	0
22	22.6	23.0	18	5	7×24	623
51	22.1	21.4	10	1	7×24	234
46	22.2	22.0	7	1	7×24	152
47	26.8	28.4	None	1	7×7	0
22	23.2	22.4	11	5	7×24	346
51	22.8	21.1	8	1	7×24	124
46	22.7	21.2	4	1	7×24	86
47	25.2	27.9	None	1	7×7	0

As can be noted from Table 2, trapping devices can discover low-density pest hazards in advanced compared with traditional check in person. On checking No.47 pest-free wheat warehouse in the test, 48 *C. ferrugineous* were captured during the seven hours from 17:00 to 24:00 in September, 17 while this number dropped to 0 seven days later. Light was switched open for 24 hours in No.9 test warehouse and in the 4000-cubic-meter empty warehouse that is checked as pest-free in person, 252 *C. ferrugineous* were captured while the number dropped to 0 five days later. The test discovered that the best killing effect came when temperature was above 26°C inside the warehouse. Pests screening and attracting quantity is specified in Table 2.

When the temperature was between 20°C and 26°C, the effect dropped by half; when the temperature dropped to below 20°C trap catch was scarce. The negative pressure fan suction method was adopted for collecting pests, around 30% of pests were observed to fall one square meter below the light after bumping into the lamp wall, so a fire blanket and food attracting dish should be used for collection. During the test hour, four test warehouses captured grain pests dominated by *C. ferrugineus*. In the grain warehouse, continuous light hours help decrease density of grain pests outside the warehouse and reduce access of grain pests into warehouses, which is particularly important for warehouses that need to open windows at night to dissipate heat.

Table 2 indicates that the two methods share the same trend and are positively related. So in actual operation, new comprehensive trapping devices can be used to monitor changing status of pest population inside a warehouse, which saves time and labor.

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