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Partial Pest Fumigation Technology Research for Grain Piles

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Abstract: Partial pest fumigation technology for grain piles has always been a very complicated problem, by using exploring tube for dosage administration, with cloth bags of aluminum phosphide buried together and by means of the pipes for partial dosage administration to kill pests. However, it never covers all the fumigation vacancies, and solves uneven gas concentration problems. Through years of practice and contrast, we find that the recirculation fumigation method fixed with fumigation tubes is the most effective in the areas of pest infestation.

Key words: partial pest infestation, recirculation fumigation

In recent years, the technology applications for low temperature grain storage and balanced grain temperature have been widely promoted in grain depots, which have tremendously disrupted the pests' living environment and prevented the spread of pests so that the incidence rate for grain pests in large areas grows less. However, the partial grain insect infestation damages arising from various factors are still running rampant in many grain depots. If fumigation for the entire depot is adopted, it will not only cost more, but also labor intensity will be increased. At the same time, if there is no thorough fumigation, pests will spread to the whole depot causing other unfavorable factors. Thus, partial fumigation for grain pest treatment is the fundamental solution for this problem.

1 Causes for Partial Pest Spread

1.1 Poor Ventilation

In winter, the whole depot is not covered by mechanical ventilation, leading to big temperature differences with neighboring grain piles so that variations in grain temperartures within a grain pile can cause convection air movement which can cause increased moisture content for grain piles due to condensation of moisture. If this moisture shift phenomenon can not be controled in a short period of time, fungi in the grain piles will begin to propagate. Because the heat for microbial activities can not be released, it leads to the heat accumulation providing a favorite environment for the pest reproduction in stored grain piles. During the seasonal conversion periods between autumn and winter, between spring and summer the depot warehouse doors are opened often for wind ventilation, but a sudden temperature drop or increase in a large scale outdoors tends to cause condensation of moisture on the grain pile surface, on the warehouse doors and corners. If this phenomenon lasts, the partial grain pile will be subject to pest damage.

1.2 Wind net Design Defects before the Storage

Especially for the grain deposited during the hot temperature period in summer, although the grain depot has been disinfected, it keeps the temperature in individual parts of the grain depot still above 25℃ resulting from wind network design defects and bad winter ventilation. Because of the temperature difference within grain piles, the spread phenomenon of dampness and heat makes grain – storage temperature and humidity ideal for pest development and reproduction.

1.3 Halfway Disinfection

During phosphine fumigations, due to improper operation methods or inadequate dosage, some pests with phosphine resistance are not completely killed. After fumigation gas has dissipated, surviving pests will gather in warm humid areas favorable for living, feeding and breeding, which would trigger an outbreak for a new partial pest infestation, with increased phosphine resistance being bred by surviving insects.

1.4 Automatic Grading

After the grain enters the depot, because of

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automatic grading in the grain bulk, the imbalanced distribution for internal impurities, water content and grain quality tend to result in the poor – quality grain accumulation with more impurities and high water content in a certain area. This kind of partial environment for grain piles is particularly suitable for pest growth and reproduction. Under appropriate conditions, it can become partially pest – prone.

Of course, apart from the above – mentioned pest – prone factors, improper comprehensive pest control can cause pest infection in partial grain piles. The grain stored in hot and humid season is prone to form partial hot and humid environments within grain piles, which is suitable for renewed eggs – hatchings and pest infestation. In short, on one hand partial pest damage in the grain bulk causes the partial heat, or even mildew, which is a direct impact on grain storage safety, On the other hand, pests spreading throughout the warehouse has increased the difficulty for grain storage. If the fumigation for the whole depot is adopted, the expense will be much higher. Sometimes the temperature where pests are infested is much higher than other parts, so that fumigation gas does not infiltrate sufficiently to kill pests[1]. For this, taking a scientific and rational partial fumigation approach for partial pest disasters, we not only achieve maximum results with reduced effort, but also it is more effective. The investigation into partial grain pest fumigations is as follows.

2 Partial Pest Fumigation for the Grain Bulk

Partial pest fumigation for grain piles technology has been a very complex problem, and exploring tube administration, concentrated burial of aluminum phosphide hop – pockets or sinusoid vessel partial dosage or other means still can not deal with the fumigation vacancy and uneven gas concentration problems. Through years of practice and contrast, at the place where pests run rampant, the recirculation fumigation method fixed with portable or moveable fumigation probe tubes are the most effective. Around and at the centre of the pest infestation area, with the grain surface covered with film sheets, gas tubes (Fig. 1) are arranged to transmit the fumigation gas to the center sites of the grain pest reproduction (pest hot – spots), so that the effective concentration of fumigation gas is confined to a stenotic area making for a three – dimensional gas siege for pests so as to annihilate the localized pests. However, during the fumigation process, the gas diffusion will reduce the gas concentration in the pest intensive concentration areas. For this, we must pay careful attention to the gas concentration of partial fumigation at the pest infestation areas. When necessary, more gas should be added to keep the insecticidal gas density above the effective concentration. The gas concentration can be measured by setting detector tubes in the grain mass area being fumigated. Fumigation gas tubes can be buried in grain piles by using sampling devices, and this technology in China has got almost mature. Developed and manufactured by Chengdu Grain Storage Research Institute under State Grain Reserve Administration, the processing machine of partial grain piles has been successfully applied in many of the granaries, which proves the maturity of the technology.

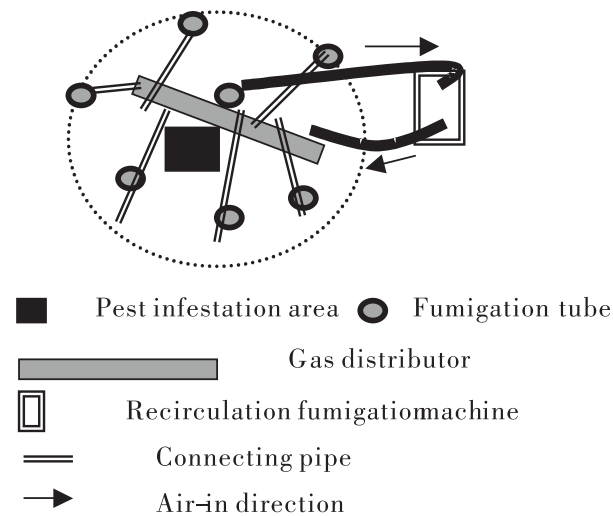

Fig. 1 Processing machine for partial grain piles (planform)

3 Do and Don't Partial Recir Culation Fumigation

3.1 Phosphine Concentration Measurement

The partial pest spread causes hot temperature spots in the grain pile, which creates temperature differences that causes hot and cold air convection air currents to flow within the grain piles. These slow moving air currents directly affect the concentration homogeneity of phosphine, so the concentration at the fumigation areas of phosphine can not be known at any given time. Because of this, it often leads to halfway, poor, ineffective fumigation, or excessive fumigation which can adversely affect grain quality. In the grain piles of fumigation, the scientific arrangement for phosphine detection points is

very necessary, so we can always know on a real-time basis what the phosphine concentration values are in the target fumigation area. With this valuable information, we can add dosage or suspend dosage delivery, as needed. This allows the partial fumigator the ability to keep an effective concentration of phosphine around the center of insect infestation in the grain piles, greatly improving insecticidal efficiency. The following arrangement of phosphine detection points is very scientific[2]

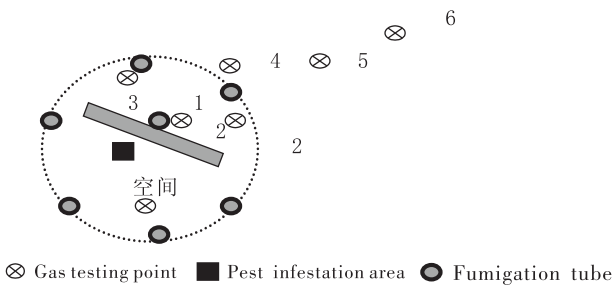

Fig. 2 Phosphine detection point arrangement (planform)

Table 1. Phosphine Detection point position in grain piles

Detection point	Vertical distance from the grain surface (m)	Distance from the central tube (m)
1 – 1	2.5	0.3
1 – 2	4.5	1.2
2 – 1	0.6	1.2
2 – 2	1.5	1.2
2 – 3	2.5	1.2
2 – 4	4.0	1.2
2 – 5	5.0	1.2
3 – 1	2.5	1.8
3 – 2	4.0	1.8
4 – 1	3.2	2.5
5 – 1	0.5	3.0
6 – 1	0.5	5.0
Airspace	0	1.0

3.2 Determination of Confinement Method and Time

On the grain surface, with film sheets covering the grain pile surface above target area, film sheet edge should keep distance from fumigation tubes at least 1m beyond the tube, and is vertically buried more than 50 cm under grain piles surface. The interface with tubes must be closely confined (Fig. 2, Table 1).

Phosphine fumigation is a very complicated process, not only requiring the effective phosphine gas concentration, but also making the effective gas concentration last long enough to kill all life stages of the pests. As for Phosphine imago and larvae pest fumigation, insecticide concentration and time requirement is lower than for eggs and pupae. Grain bulks are half-closed in the process of fumigation. Phosphine gas under the films spread around in the grain piles. If not promptly fumigated before pest populations expand, in the pest infestation area it is difficult to form an effective concentration for pest killing. Before the partial fumigation, we must know the location and size of the pest infestation area, grain bulk temperature, dosage concentration, and pest species state. As for comprehensive factors such as the pests drug resistance, a thorough investigation should be made to work out the best concentration and confinement fumigation timetable. Listed in " Phosphine Recirculation Fumigation Technical Specification" (LS1201 – 2002), for different temperatures of phosphine, effective concentration and confinement time for pest killing are given (Table 2). In the operation, based on some experiment results we may see the results as a reference to ensure the insecticidal effect.

Table 2. Recirculation fumigation different confinement time, temperature and pest species Phosphine concentration reference table

Pest species	Temperature (℃)	Confinement time (d)		
		14	21	28
1. Sensitive pests: corn weevil, gnawing beetle, siligua gnawing beetle and other sensitive species	>25	200	150	100
	20 – 25	250	200	150
	15 – 20	–	250	200
2. Drug resistance pest: lesser grain borer, rice weevil, oblate gnawing beetle, red flour beetle, Indian Meal Moth and other species of insects	>25	300	250	200
	20 – 25	350	300	250
	15 – 20	–	350	300

3.3 Phosphine Flowing Direction

Phosphine has advantages, such as strong penetrating property, strong diffusibility, effective pest killing, convenient use, low cost, low pollution and residual. It is currently one of the world's best fumigants[3]; During a local partial phosphine fumigation, to form an effective gas concentration, the fumigator must properly distribute recirculation fumigation tubes down through the grain pile into the pest infestation zone. Then, through the gas distributor, phosphine delivered by the recirculation fumigation machine can flow downward through the fumiga-

tion tubes which are pressed into the grain piles. Thus, the pests are surrounded by leathal concentrations of gas, and through suction created by the central fumigation tube (Fig. 3), phosphine is accumulated in the pest infestation area, improving insecticidal efficiency. The recirculation blower then continues to recycle the fumigant gas, keeping it flowing through the pest infestation areas.

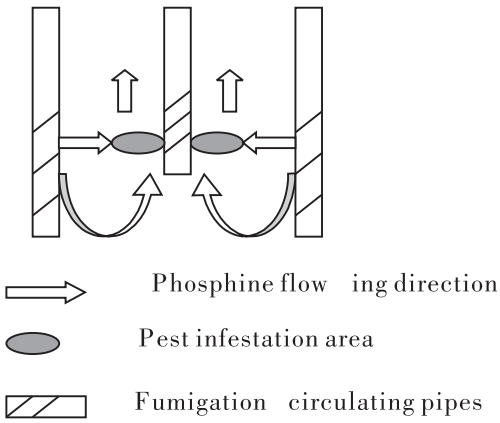

Fig. 3 Side view of phosphine's flowing in the grain piles during a local fumigation

4 Conclusion

4.1 By using the processing machine of grain piles, the partial pest fumigation has advantages, such as low dosage, low-cost, light labor intensity; rapidly making the phosphine of various parts maintain uniform concentration[4].

4.2 The partial pest infestation causes the hot sport temperature in grain piles, such as the temperature over 32℃, while at other parts of grain piles temperature is lower. Under this situation, we should conduct partial fumigation after cooling the grain[5], or else it would lead to condensation of moisture. Big temperature difference in grain piles forms strong interior airflow, and it easily lead to the loss of phosphine gas, affecting recirculation fumigation effects.

4.3 If large areas of pest infestations cover large areas near the grain pile surface, it is better not to use partial fumigation methods for pest control.

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