Pak. J. *Agri. Sci., Vol.* 31, *No.* 4, 1994

DEVELOPMENT OF PHOSPHINE FUMIGATION TECHNIQUE FOR BAG CUM BULK WHEAT STORED IN HOUSE TYPE GODOWNS

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In house type godowns, bag cum bulk storage of wheat is common in Pakistan Agricultural Storage and Services C(';poration (PASSCD). For protection of stored wheat in these godowns, Phosphine fumigation is always done by using aluminium phosphide (AlP) tablets. In this practice total number of tablets are scattered around and on the surface of the stack. This method was tested and proved to be ineffective because of insufficient penetration and retention of phosphine gas in deeper zones of the stack. To improve upon phosphine fumigation two other methods (multiple and dosing pipe application methods) were tested. In multiple application method a higher dose rate was used in two successive applications while in dosing pipe method, perforated PVC pipes were used in the bulk wheat to apply the AlP tablets. Out of these three methods, dosing pipe method proved to be the most effective and resulted in to better retention and distribution of phosphine gas in different zones of the bulk wheat.

INTRODUCTION

House type godowns constitute a major proportion of the wheat storage facility with Pakistan food handling agencies. Basically these godowns are meant for bag storage but Pakistan Agricultural Storage and Services Corporation (PASSCD) is using them for bag cum bulk storage to enhance their storage capacity from 1100 to 1600 mtJgodown (Qureshi, 1989). In this practice, bulk wheat is contained in an area enclosed by pad walls made of wheat filled gunny bags. PASSCD is trying to modify these structures for complete bulk storage of wheat for efficient handling (Acasio and Javed, 1992). The present total capacity of bag cum bulk wheat storage by PASSCD is about 450,000 mt.

Many of the PASS *CD's* house type godowns arc in good shape and arc fumigable for the whole godown fumigation (Halliday, *et al.* 1990) The present practice for insect pest management in these god owns include (a) surface spraying of empty dogown's interior with primiphos methyl (actellic) (b) Whole-godown phosphine fumigation by using aluminium phosphide tablets at the rate of one tablet per cubic meter of the space.

The studies carried out by Alam and Ahmad (1989) and Alam *et al. (1991)* indicated disparate levels of resistance in stored grain insect pests in Pakistan against the toxic action of phosphine gas. Under-dosing, particularly due to inadequate exposure periods over the years is the main reason for the development of high resistance to major stored grain insect pests in Pakistan

(Taylor, 1986). For the control of phosphine resistant insects Winks (1986) and Mahmood *et al.* (1991) have proposed an increase in the exposure perio.d of phosphine gas in a well sealed enclosure rather than increase of AlP tablets to be a preferred strategy. The method of application of AlP tablets also plays a significant role in this context. Besides, uniform distribution of phosphine gas in all parts of the enclosure, it is also highly desirable for complete control of insect pests.

The present study was an effort to improve the AlP tablets application techniques for the control of stored grain insect pests in bag cum bulk storage. The present fumigation procedure being practiced by PAsseo was compared for its effectiveness with different methods tested here in order to maintain lethal concentration of phosphine gas in all parts of the grain bulk for sufficient long period of time.

MATERIALS AND METHODS

The experiments were conducted in house type godowns located at PASSeO complex at Manga Mandi near Lahore. Each godown was 30.58 m long, 18.93 m wide and 5.5 m high. Bulk wheat was loaded manually in each godown in the form of a single stack in the center. Wheat was supported by two bags wide pad wall on the four sides. Thus, the actual size of the bulk cum bag stack was 28.78 m in length, 17.10 m wide and 3.4 m high. A gangway of about 0.75 m was left all around the stack for inspection and fumigation purposes. The top of the wheat bulk was levelled manually. Before loading, the floor, walls and roof of each god own were sprayed with 1% Actcllic 50 E.e by using a power spraycr.

Three different methods of AlP tablet application were tested and com pared for phosphine fum igation. Retention of phosphine gas in free space and different representative zones of the grain mass was monitored for comparison. These methods were:

I. Single application Method. This is a routine fumigation method being used by PAsseo in bag cum bulk storage and was used to serve as a reference for comparison. In this method, AlP tablets were applied in a scaled godown at the rate of one tablet per cubic meter of spate and all the 3184 tablets were applied in single application. The 60% of the total tablets (1910) were spread around the stack in the gangways while the rest (1247) were placed on the top surface of the grain bulk.

2. Multiple Application Method. In this method, all AlP tablets were used but applied in two parts. Of the total number of 7lJ60 tablets used (at the rate of 2.5 tablets pt:r cubic metre), the first application of 4776 tablets (at the rate of 1.5 tablets per cubic meter) was followed by a second application of 3184 tablets (at the rate of 1.0 tablet per cubic metre) after an interval of 48 hours. The first application was done as described in single application method. In the second application, the AlP tablets were thrown inside the sealed god own through an opening made by removing a glass from one of the ventilators. This glass was fixed again as quick as possible to keep the conditions sealed.

3. Dosing Pipe Method. In this method four pve pipes were fixed with each of the central pillars of the godown before loading of wheat. The bottom end of each pipe was about half meter above floor level. Each pipe was 13 cm in diameter and 4 m in length, having rings of

perforations, Each ring was separated by a 50 cm blank portion (Figure). Three fourth portion of each pipe was immersed in the wheat bulk. The total number of AlP tablets used in this method was same as used in the single application method Le. 3184 (at the rate of one tablet per cubic metre of space). Thirty percent of the total number of tablets (956) were mixed with grain and poured into the four pipes (each pipe containing 239 tablets) in such a way that two bands of such mixture separated by normal grains were formed (Figure). The remaining 2228 tablets were scattered around the grain stack and on the surface of wheat bulk.

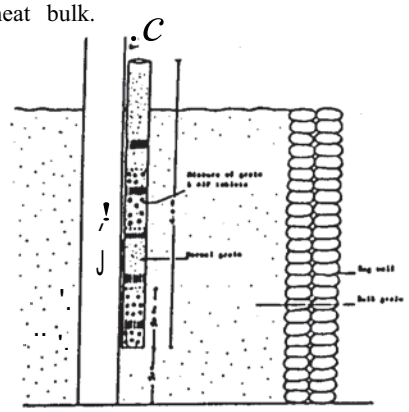

Fig. 1. PVC pipe immersed in bulk wheat for application of AlP talets.

For the monitoring of fumigant concentration, nylon capillary tubes having internal diameter of 2 mm were installed in different representative zones of the stack. These representative zones were top peripheral, middle semi peripheral and bottom central layers of the wheat bulk. One tube was also fixed in the free space above the stack. The gas was monitored after every 24 hour from these zones by using a Cititox digital meter (Haris and Cox, 1990). Each godown was sealed by closing all doors and the ventilators and by applying mud plaster on them to make them air tight.

RESULTS AND DISCUSSION

Results on the average values of phosphine gas concentration monitored in various zones of wheat bulk and the free space in godown are presented in Table 1, which indicated that:

a) When AlP tablets were applied according to the currently used method i.e. single application at the rate of one tablet per cubic metre of space, peak concentrations of 620 and 515 ppm of phosphine gas were reached after one day in the free godown space and the top peripheral zone of wheat bulk respectively. During this time however, very little gas had reached the bottom central parts of wheat bulk (only 40 ppm). Peak concentrations of 440 and 245 ppm of phosphine were reached respectively in the middle semi-peripheral and bottom central parts of wheat bulk on the second and fourth day respectively after AlP application. Phosphine gas concentration above 200 ppm could be maintained only for three to four days in the different parts of wheat bulk (Table) at different times.

b) In the case of multiple application method involving a 2.5 times increase in the quantity of AlP, peak concentration of 890 and 730 ppm phosphine gas were reached in the free godown space and top peripheral zone of wheat bulk respectively on the fourth day. Peak concentrations of 400 and 2S0 ppm phosphine were however, reached in the middle semi-peripheral and bottom central zones of wheat bulk on sixth and eighth day respectively after AlP application. Phosphine concentrations of 200 ppm

much higher than 200 ppm were recorded throughout the period of observation i.e. up to nine days after the application of AlP :ablets (Table).

Ahmad *et al.,* (1987) had recommended that in view of the development of resistance in storage pests, a minimum concentration of 200 ppm of phosphine gas may be maintained in all parts of the space for a minimum period of seven days for effective Iurnigatiou. Through their simulated laboratory studies, Mahmood *et al.,* (1991) have shown that, for complete mortality of mixed pest populations (resistant and susceptible stains), a phosphine concentration of above 240 ppm was required with an exposure time of at least 14 days although above 90% mortality was achieved in an exposure time of seven to eight days. In the view of these observations and studies, the dosing pipe method tested here would seem to be the most appropriate method which will control insect pests in bag cum bulk wheat stored in house type godowns by PASSCD.

ACKNOWLEDGMENTS

The present study was conducted with the support of USAID's Storage Technology Development and Transfer/Food Security Management project, contract No. 391-0491-C-00-6080-00. Their support is greatly acknowledged.

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