Study on the application techniques of stored grain protectant

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Abstract

Owing to their high efficacy and low cost, Fenitrothion and Malathion both are the most commonly used stored grain protectants. Results showed that the mixture of deltamethrin with Malathion, fenitrothion or pirimiphos-methly could extend the insecticidal spectrum, and have synergistic effectiveness. The pirimiphos-methyl and deltamethrin both showed the stable effectiveness under subtropic climate conditions By using the formulations of granule and rice hull used as the carrier, the pesticides degraded gradually and slowly, and no high peak appeared in the whole treatment period. The residue amount of pesticide in wheat flour and its products were higher than these in the milled rice and its products These four protectants showed no harmful acttion to the quality of cereal seeds.

Introduction

Malathion was recommended as the first protectant used in the control of stored grain pest since the beginning of 80's. Practise in more than ten years demonstrated that the protectant was welcomed by the national grain depots and farmers more and more due to its high efficacy, low toxicity, long persistence and wide adaptability to environment. Thus it provides an efficient measure for the integrated management of stored grain pests There are four pesticides (Malathion, Fenitrothion, Pirimiphos-methyl and Deltamethrin) widely applied in China It can be predicted that new protectants and correponding applied technology will be developed unceasingly (Zhang, 1997)

Every pesticide possesses its own characteristic in the control of store grain pests. For the purpose of bringing the efficiency into full play, it is necessary to investigate the corresponding applied technique of this pesticide.

Selection of the regular pesticide

Under the normal applied condition, the comprehensive comparison on the control efficacy and the cost (Ratio of efficacy and cost) of the following five protectants (Malathion, Fenitrothion, Malathion-Deltamethrin mixture, Pirimiphos methyl and Deltamethrin) shows the result as 1 1.1 1.2 2 6.7 respectively In addition some special pesticides are selected for the special requirements, such as high temperature, high humidity, special pests, resistant pests etc. Malathion and fenitrothion are the most widely applied pesticides. In Australia, the controlling cost of malathion and fenitrothion is more than one time cheaper than that of pirimiphos-methyl and chlorpyriphos-methyl (Bengston, 1986).

Nearly 50 tons of malathion have been applied annually in the national grain depot in the major grain producing province Jiling since 1990 and a satisfactory efficacy was reported in several years It is recommended to apply pesticide at once on the grain when it was put into storage, which is enough to prevent the stored grain from pest damage in whole year. The applied method in the integrated management is as follows. After the harvested grains with high moisture content are dried, the grains in the upper 30 cm of layer and the outer wall of grain bin are treated with malathion, in order to prevent the foreign pests invading. Only 1.5 kg of 70% malathion emulsion is needed to apply in every 150 tons of grain. This measure replaced the original fumigation method and achieved the objective of less pesticide applied, low cost and good efficacy

In other areas, the control of stored grain pests mostly used the measure of treating the upper layer of grain bin with protectant and fumigating the middle and lower layer of grain bin with aluminium phosphide

The technique of treating the whole bin with protectant is recommended to use in those grain depots with high mechanizing ability in putting grains into storage. The application of those protectants, such as malathion and fenitrothion in the protection of stored grain and seeds from pest damage was adopted in the peasant households in Zhejiang, Hubei, Guangxi, Shanxi, Sichuan and Guangdong provinces, and a satisfactory efficiency was obtained It minimizes the original 5 – 10% losses caused by the pest damage and replaces the application of fumigant as well as improves the safety situation and prolongs the persistence of efficacy

Insecticidal spectrum and mixed formulation

Results showed that those organophosphorus pesticides, such as malathior fenitrothion and pirimophos-methyl, performed satisfactory efficacy to maize weevil (*Sitophilus*

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zeamais Motschulsky) and not to Lesser grain borer (*Rhiaopertha dominica Fabricius*) (Zhejiang Grain Science Research Institute, 1986) On the contrary, the deltamethrin, as the representative of pyrethroid pesticide, showed diversified effectiveness to these stored grain pests. These two groups of pesticide constitute different insecticidal spectrum For the purpose of controlling different species of pests and broaden the insecticidal spectrum of certain pesticide, a mixed formulation of pyrethroid and organophosphorus pesticides was put forward in the early stage (Bengston et al., 1980). For the purpose of further understanding of the synergistic property of these two groups of pesticide on the efficacy, the experiment was conducted These results are showed in Figure 1 As can be seen from this figure, the mixture of deltamethrin and malathion, fenitrothion or pirimiphos-methyl showed a certain degree of synergistic activity in the control of *Sitophilus zeamais* weevil. The mixed formulation can decrease the applied dosage (Zhang et al , 1990a) Duguet et al. (1990) published a similiar experimental result.

A comparison on the environmental stability of pesticide

There is a significant difference in the efficient protecting period to pests and the degradative rate of pesticide residue in the stored grain among various pesticies. Under the normal productive condition, the stability of pesticide residue in grain depot was decreased as the following order: pirimiphos-methyl > fenitrothion > malathion (Zhang et al , 1993).

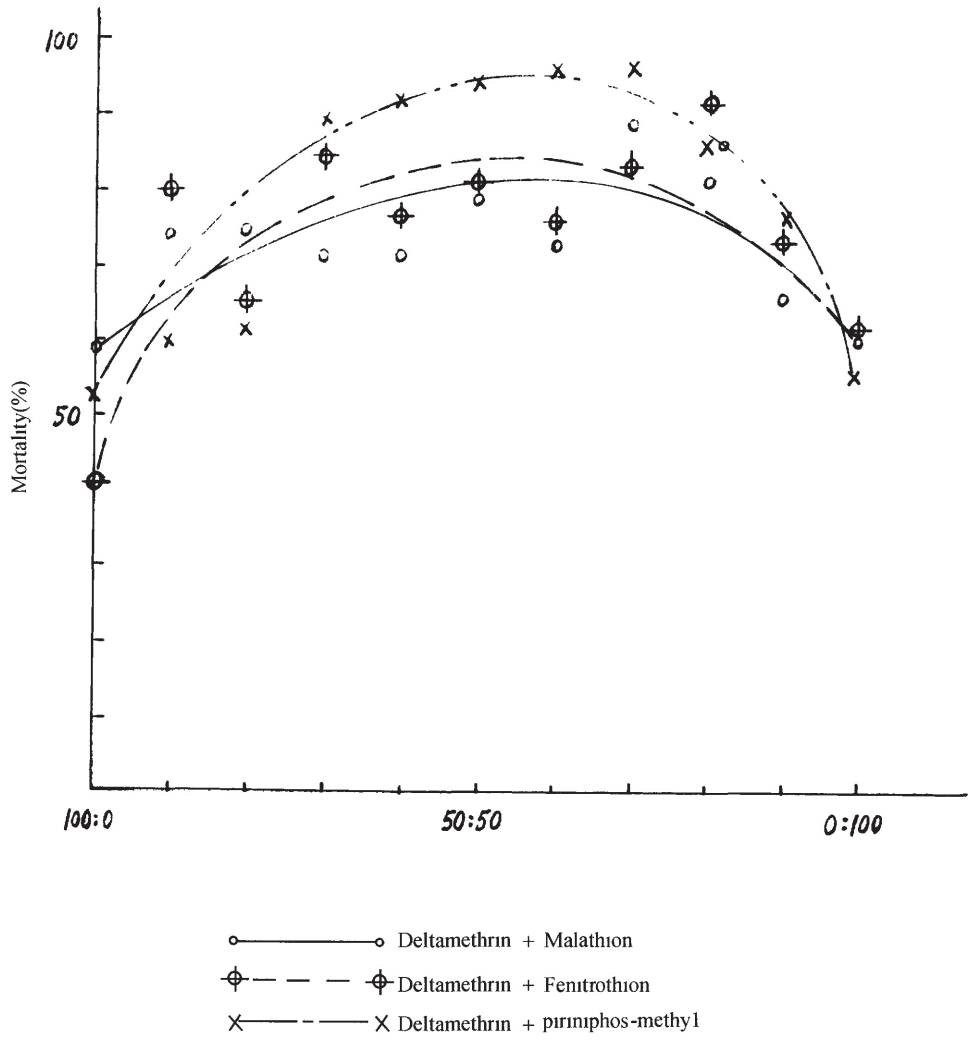

Fig.1. Combined action of the mixed preparation of action of Deltamrthrin and three organophosrus insecticides on corn weevil

In the summer (August – October) of Zhejiang and Guangdong provinces, the average temperature of stored grain was 29.5℃ and 36.2℃ respectively The efficacy of pirimiphos-methyl to *S. zeamais* weevil showed a high effectiveness under the high temperature and high humidity condition of Guangdong province (Figure 2). However the efficacy of fenitrothion in Guangdong was lower than that in Zhejiang (Zhang et al., 1990b) The experiments on various protectants conducted by Guangdong Grain Science Research Institute also demonstrated this result (Hua et al., 1986). Desmarchelier and Bengston (1979) conducted an investigation on the degradative rate of 17 protectants. The results also confirmed the above mentioned results.

Deltamethrin showed a satisfactory efficacy in the control of *R. dominica* weevil and the degradative rate of residue in stored grain also showed a stable pattern The half-life ($\frac{1}{2}$ t) of deltamethrin in the grain depot condition was around three times longer than that of malathion (Zhang et al. 1993). So, it is suitable to be used in the control of *R. dominica* weevil in the southern China with high temperature and high humidity

Influence of formulation on the pesticide residue

Regularly, the dust formulation mixed with the stored grain often causes a high residue level in grain at the early stage after treatment, and the unit weight of wheat is decreased accordingly, thus influencing the quality of stored grain (Yu,1985) Besides, the powder induces the harmful influence on environment during the application period. Two new formulations were developed. One is the use of rice hull as the carrier which could be prepared for immediate application (Zhang et al., 1980) and the other is the granule formulation manufactured by the industrial process (Ge et al.,1996). The property of these two formulations is similar to the controlled release formulation. It resulted in a low residue of pesticide for stored grain. Especially the granule formulation, whose residual performence showed that grain after treatment with pesticide by the peasants whenever if the grain is necessary for use, and need not be worried about whether the pesticide residue in grain is higher than the MRL.

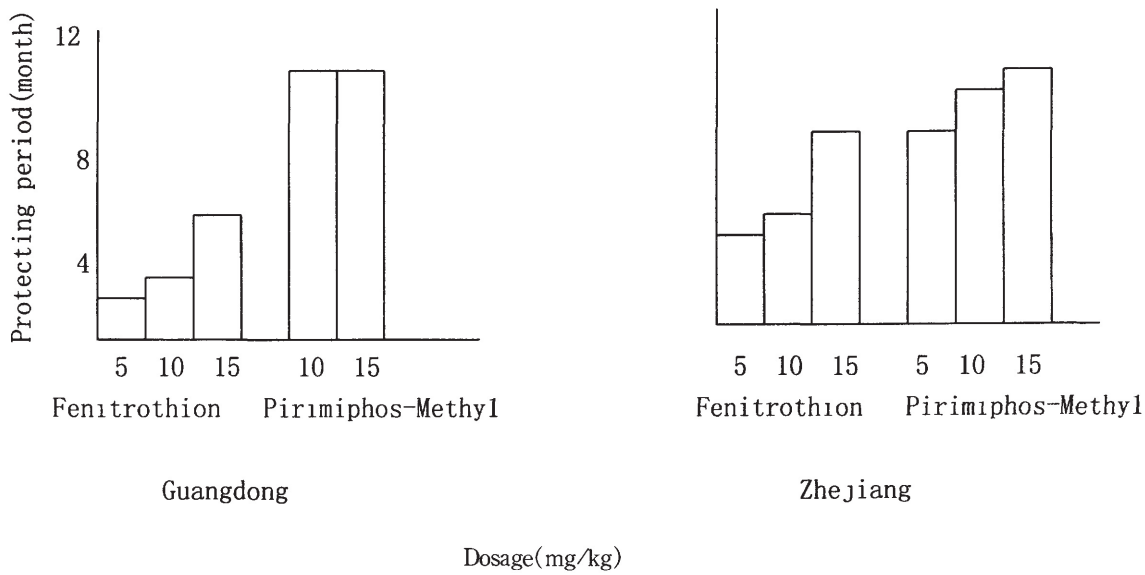

Fig. 2. Comaparison on the protecting period of Fenitrothio and pirimiphos-Methyl on corn weevil (*Sitophilus zeamais*) in Zhejiang and Guangdong province

Pesticide residue in the processing of rice and wheat

The residue of malathion, fenitrothion and pirimiphos-Methyl in the milled rice and cooked rice was much lower than that in the processing products of wheat—wheat flour and steamed bread (Table 1). It can be attributed to the following reasons. The processing of rice undergoes the process of rice hull and rice bran, and the hull were separated from the rice, then the rice was sorted from the bran, thus the pesticide which existed mainly in the hull bran portion of rice can be removed thoroughly, with only a less amount remained in the inner milled rice grain After washed and cooked with water, the pesticide residue was washed and degraded almost completely On the other hand, the processing of wheat is that the whole wheat grains were grounded into flour and the bran Then the bran was separated from the flour Owing to the pesticide residue being mainly situated in the bran portion, so the pesticide

residue comes to the wheat flour with the bran. Although several times of separation process of wheat flour from bran are carried out, it is difficult to remove the pesticide residue from the flour completely Thus, the residue of pesticide is higher in wheat flour than that in the milled rice. Although the fermentation and steam process are carried out in the preparation of steamed bread, however, no washing process is conducted, so more pesticide residue are remained.

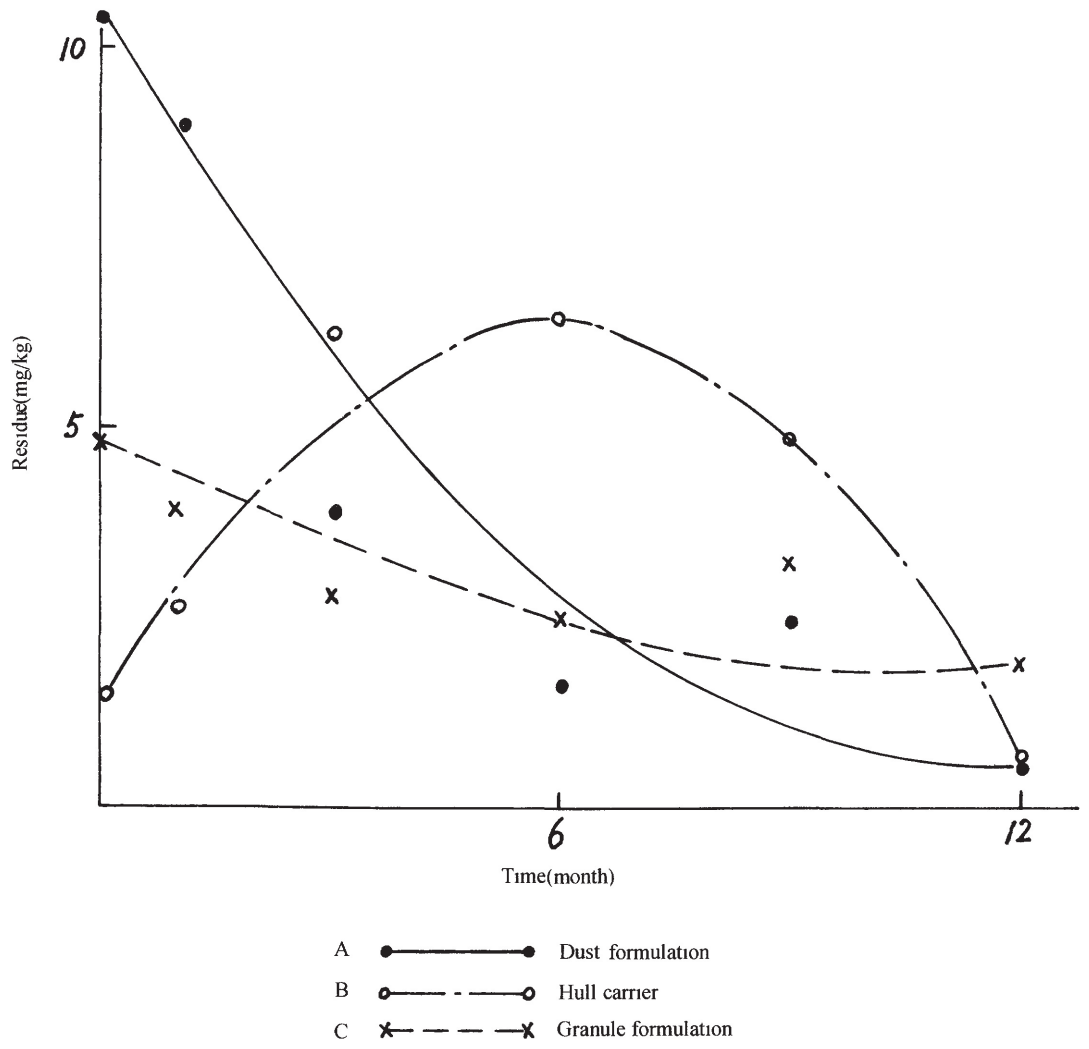

Fig.3. Degradative dynamics of various formulations of Malathion(30 mg/kg) in wheat

The influence of protectant on the quality of cereal seeds

According to the experiment of treating the rice, wheat, barley, corn and sorghum with the regular dosage and the one to two times higher dosage of malathion (Zhejiang Seed company et al., 1981), fenitrothion, pirimiphos-methyl (Zhang et al., 1986) as well as the mixed formulation of deltamethrin and malathion (Zhejiang Grain Science Research Institute, 1990c), the tested pesticides showed no harmful effects on the seed quality. However, if the dosage of malathion is too high (for example, 100 times higher) it may cause the phytotoxicity to seeds (Zhejiang Grain Science Research Institute, 1982).

Table 1. comparison on the residue of Malathion and Fenitrothion in rice and wheat grains and their processing product (mg/kg).

Grains	Pesticide	Stored period (month)					
		0	1	3	6	9	12
Rice	Malathion	–	11.4	10.7	6.3	3.1	1.7
Rice	Fenitrothion	12.5	8.5	12.5	8.6	5.8	1.7
milled Rice	Malathion	–	ND	ND	ND	ND	ND
milled Rice	Fenitrothion	–	ND	2.6	ND	ND	1.2
cooked rice	Malathion	–	ND	ND	ND	ND	ND
cooked rice	Fenitrothion	–	ND	ND	ND	ND	ND
Wheat	Malathion	7.1	5.6	3.5	3.2	3.7	1.8
Wheat	Fenitrothion	6.5	5 8	6.7	5.7	4.5	2.3
Flour	Malathion	2.6	–	0.7	2.5	1.9	1.2
Flour	Fenitrothion	1.3	–	0.8	2.2	1.3	1.1
Steamed bread	Malathion	0.86	–	0.23	0 25	0.22	0.18
Steamed bread	Fenitrothion	0.4	–	0.47	0 26	0.39	0.19

References

Bengston, M , Connel, M., Davies, R., Desmarchelier, J., Edler, B., Hart, R , Philips, M., Ridley, E., Ripp, E , Snelson, J. And Sticka, R., 1980. Chlorpyriphos-methyl plus bioresmethrin, methacriphos, pirimiphos-methyl plus synergised bioresmethrin as grain protectants for wheat. Pestic. Sci., 11,61 – 76.

Bengston, M. 1986. Personal communication.

Desmarchelier, J.M. and Bengston, M. 1978. The residual behaviour of chemicals in stored grain. Proceedings of the 2nd International Working Conference on Stored-Products Protection, Ibadan, Negeria, 10 – 16 Sept., 1978, PP 138 – 151

Duguet, J.S , Fleurat-Lessard, F. and Peruzzi, D., 1990. The advantage of mixed preparation of deltamethrin and organophosphorus insceticides for the protection of stored cereals A review of recent trials. Proceedings of the 5th International Working Conference on Stored-Products Protection Bordeaux, pp. 517 – 521.

Ge Zhigang, Zhang Guoliang and Zhu yongnian, 1996 Investigation on the applied techniques of Fang-Chong-Ling (malathion) granule formulatiom in the control of stored grait pests. Journal of Grain storage, 25(6),17 – 21. (in Chinese)

Hua Dejian, 1986. Efficacy of some grain protectants in Guangdong, Proceedings of the 1st Annual Meeting of China Grain Storage Society. (in Chinese)

Yu Shunan, 1985. Influence of malathion filler on the unit weight of wheat. Communication of Grain and Oil Storage Science and Technology, 4,24 – 26. (in Chinese)

Zhang Guoliang, Li Yanhong, Xu Baozheng, Ye Zhongxiong and Shen Zhicheng, 1982 Investigation on the ununiform pesticide application technique by using the rice hull carrier. Acta Phyto-phylacica Sinica, 9 (1), 55 – 60. (in Chinese)

Zhang Guoliang, Li Yanhong and Xu Baozheng, 1986. Influence of stored grain protectants-fenitrothion and pirimiphos-methyl on the quality of cereal seeds Seed, 5 – 6:25 – 27,32 (in Chinese)

Zhang Guoliang, Li Yanhong, Fu Baokang, Zheng, Junkui and Ge Zhigang, 1990a. Investigation on the efficacy of the mixed preparation of deltamethrin and organophosphorus protectants in the control of Lesser grain borer (*Rhizopertha dominica Fabricius*). Zhejiang Grain and Oil Science and Technology, 3 – 4, 14 – 17. (in Chinese)

Zhang Guoliang, Li Yanhong, Fu, Baokang, Zheng Junkui and Ge Zhigang, 1990b. The applied investigation on the control of stored grain pests with pirimiphos-methyl, Journal of Grain Storage, 19(1), 3 – 12 (in Chinese)

Zhang Guoliang, Yu Guoying, Lin Jiang, Wang Zebing and Zhang Dahong, 1993. Investigation on the residue, degradation and distribution of malathion, fenitrothion, pirimiphos-methyl and deltamethrin in stored grain.. Acta China Grain and Oil, (in Chinese), 8(1), 1 – 4.

Zhang Guoliang, 1997. Some advances of grain protectants in China. J. Chinese Cereal & Oil Association, (Special): 37 – 39. (in Chinese)

Zhejiang Grain Science Research Institute, 1980. Experimental report on the application of high quality protectant of stored grain pests – Malathion. (Internal

information). (in Chinese)

Zhejiang Grain Science Research Instituete, 1986 Investigation on the Deltamethrin in the control of stored grain pests. Journal of Grain Storage, (in Chinese)5,69－73.

Zhehjiang Grain Science Research Institute, 1990. Productive experiment on the mixed preparation of Deltamethrin and Fan-Chong-Ling (malathion) in the control of stored grain pests (Internal information) (in Chinese)

Zhejiang Seed Company, 1981 Field trials on the application of Malathion in the protection of seeds of barley, wheat, upland rice and corn, Zhejiang Grain and Oil Science and Technology, 2,9－13 (in Chinese)