GRAIN PROTECTION AND PESTICIDE-RESIDUES TOLERANCES IN INDIA

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India has a vast rural population most of which is engaged in agriculture. Consequently, the requirement of food grains in the rural areas for food, feed and seed is immense. Ruralites and many urbanites store their seasonal requirement of food grains themselves because of a continuing food deficit. Thus of a total of about 105-110 million tonnes of food grains, about 85-90 million tonnes are stored in rural and urban homes in small quantities of 1/2 to 5 tonnes in heaps in corners of houses, in gunny sacks, in bins made of mud, bricks, metal or wood, and in a variety of other small receptacles. Most of this storage is unscientific and cross-infestation is high. Hence the losses are high. Since the grain is generally stored inside the houses, fumigation is hazardous and inadvisable. Even if it is done, despite the risk involved, the grain frequently gets reinfested because the infestation in the houses is not eliminated and in practice the storage structures are rarely insect-proof.

Considerable attention has been paid to food production, but the prevention of food losses at the house-hold level, where most of the food grains are stored, during post-harvest handling has received rather inadequate attention. To prevent losses farmers, on their own, started mixing DDT and BHC with food grains prior to storage with a view to obtaining inexpensive protection against stored-grain pests. This illegal practice is continuing because of a weak educational programme and inadequate enforcement. Many traders also mix these pesticides with food grains or apply their dusts liberally on the surface of gunny sacks containing food grains. Hence it is not uncommon to find pesticide residues in food grains. The reports on pesticide contamination of food grains were reviewed recently[1].

In fact, the very high level of DDT in human fat in India has been attributed to this illegal use of persistent organochlorine insecticides like DDT and BHC as grain protectants and not to the use of these pesticides in the National Malaria Eradication Programme and other public health programmes. The Government of India's Special Committee on Harmful Effects of Pesticides, also called the Thacker Committee, recognised the above situation and recommended that safe, non-persistent grain protectants, like malathion and pyrethrum, should be officially recommended and made readily available after necessary research[2].

In the light of this recommendation, research was initiated in the Department of Entomology, Punjab Agricultural University, Ludhiana, to determine the suitability of malathion as a grain protectant under Indian conditions. Pyrethrum, the other pesticide suggested was not researched because it was in short supply and malathion was already in commercial use as a grain protectant in several other countries. Malathion was tested as a protectant of wheat grains against adults of *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (Fab.) and larvae of *Trogoderma granarium* Everts, and on maize grains against the first two pests [3,4]. The duration of the effectiveness of malathion depended upon the dose, grain moisture and type of receptacle used for storage. In house-holds of farmers, malathion applied at 30 ppm in May-June provided almost complete protection to wheat grains against insect infestation for 6 months[5]. In another study, made in rural homes, examination of wheat in April following its treatment in September with 10, 15, 20, 25 and 30 ppm malathion revealed a loss of 6.58, 5.49, 0.79, 0 and 0% respectively against 9.08% in the untreated control.

Malathion residues on wheat and maize have been studied in relation to dose, storage period and storage conditions[6,7]. Some preliminary work was also carried out simultaneously on the effect of baking on the pesticide residues in wheat and maize. The results of these studies were confirmed and more extensive data were obtained on the residues of malathion in different fractions of treated food grains and their finished derivative[8]. It was found that the smallest loss of malathion residue during processing of grain into chapaties (61.4-77.3%) was on pearl-millet, a small grain. About 73% of malathion in maize flour was dissipated during its processing into chapaties, while more than 90% of the malathion residue from husked rice was removed during dehusking and most of the remaining residue was lost during cooking.

It must be pointed out that the above findings with respect to the extent of loss of malathion during processing of food grains confirmed the findings made earlier at the Central Food Technological Research Institute, Mysore[9]. Recent work at this Institute has revealed that in typical Indian methods of grinding and cooking, the loss of malathion from treated food grains is of the same order of magnitude as in typical European or American processing[10].

It was found that if a waiting period of 8 weeks was observed, the estimated dietary intake of malathion from consumption of food grains treated at 30 ppm level in the Punjab would be very much within the acceptable daily intake level. However, if the treated food grain was to be consumed sooner, one may like to wash the grain with water before grinding because washing was found to remove a substantial proportion of the residue.

A simple machine, called as the PAU Grain Treating Machine, was developed for treatment of food grains with sprayable formulations of approved grain protectants[11]. An estimation of malathion deposit on individual grains revealed that the treatment of the grain using this machine was very uniform, the deposit varying by a factor of less than 5 [12]. Incidentally this machine was considered to be a meritorious invention by the Government of India and it earned for its inventors a Republic-day Award in 1972.

Demonstrations of the use of malathion as a grain protectant and of the PAU Grain Treating Machine were given in several villages in the Punjab. Later it was decided to examine whether there was any demonstrable ill effect of continual consumption of malathion-treated food grains by the villagers. It was found that villagers, who had been consuming malathion-treated wheat for 7-8 months, did not have a lower blood-cholinesterase level than persons on normal diet in the same villages[13]. This was confirmed by a collaborator from the Post-graduate Institute of Medical Education and Research, in Chandigarh, who estimated cholinesterase levels separately in both blood plasma and erythrocytes. These findings and also the lack of any reports of illness as a consequence of continual consumption of imported malathion-treated foodgrains by the residents of several big cities in India reassure that there would be no danger to the health of Indians from prolonged consumption of food grains treated with malathion as a grain protectant.

In India, a population of *Tribolium castaneum*, collected from the Food Corporation of India's godowns in Naraina, near Delhi, was reported to be resistant to malathion[14]. However, this is only a secondary pest of whole grains. Recent investigations made in the Punjab did not reveal the presence of any pesticide resistance in this insect or in *R. dominica* and *S. oryzae*. Thus at present we need not worry about pesticide resistance in stored-grain pests.

Nevertheless, in India insecticide resistance will eventually develop also among different stored-grain pests. Hence there is need to be on the look out for substitute pesticides. Accordingly, 9 chemicals, viz. bromophos, cyanox, fenchlorphos, iodofenphos, phoxim, pirimiphosmethyl, resmethrin, tetramethrin and tetrachlorvinphos, all having a mammalian toxicity not exceeding that of malathion, were screened for effectiveness against adults of *R. dominica* and *S. oryzae* and larvae of *T. granarium*. Bromophos, iodofenphos, phoxim and pirimiphos-methyl proved promising and were tested as protectants of wheat grain in a small-scale storage trial lasting one year. At comparable doses, the first 2 provided protection for a shorter period, whereas the last 2 provided protection for a longer period than malathion[15]. The pattern of dissipation of bromophos and iodofenphos was similar to that of malathion, but the rate of dissipation of pirimiphos-methyl was slower[16]. During processing of treated grain into chapaties, the loss of bromophos was as fast as that of malathion, and considerably faster than that for iodofenphos and pirimiphosmethyl[15].

In another study, iodofenphos was evaluated at 10, 20 and 40 ppm doses as a protectant of maize grain against adults of *S. oryzae* and *Sitotroga cerealella* Oliv. and larvae of *T. granarium*. The 10-ppm dose provided complete kill of these insects for 7, 8 and 3 months respectively. Residues from 20 and 40 ppm were below 10 ppm level after 5 and 6 months respectively, and from 10-ppm dose these were below 5 ppm after 6 months. Processing of treated grain into chapaties and pop-corn caused a loss of 94 to 99% of the insecticide. Washing of maize grain with water removed 70-88% of the residue[16]. In another study, washing of wheat grain followed by its drying removed most of the residues of malathion, iodofenphos and bromophos. Addition of an emulsifier at the rate of 0.1% enhanced the residue-removal efficiency of water significantly, and sun-drying proved more effective than oven-drying[15]. It may be added that at 200 ppm, a dose several times higher than the effective dose, the commercial formulation of bromophos, phoxim and pirimiphos-methyl reduced the germination of wheat significantly[15].

In India there is no objection to import of food grains treated with grain protectants. However, the rules made under the Prevention of Food Adulteration Act lay down restrictions on the use of pesticides on food grains and vegetables within the country. Under these rules, food grains can be fumigated with the common grain fumigants but application of dusts or sprays of grain protectants is prohibited. Nevertheless, it is permissible to apply DDT, BHC, methoxychlor and malathion on surface of gunny sacks containing food grains, on walls of warehouses and into the empty storage space. For the contamination resulting from this treatment, a uniform residue tolerance of 3 ppm has been provided for the 4 insecticides. In 1970, realising the need for laying down pesticide-residue tolerances for all the pesticides used commercially on various food stuffs and for rationalizing the existing pesticide-residue tolerances and restrictions, the Central Committee on Food Standards, which makes the rules under the Prevention of Food Adulteration Act, appointed a statutory Sub-committee on Pesticide Residues. This Sub-committee has already made its recommendations with respect to pesticide residue tolerances on food stuffs including food grains. The revised pesticide residue tolerances are expected to be published soon.

REFERENCES:

[1] Bindra, O. S., and Kalra, R. L., A review of work done in India on pesticide residues. SPRA*. (1973) 1-44.

[2] Anonymous, Report of the Special Committee of Govt. of India on Harmful Effects of Pesticides. Indian Counc. agric. Res., New Delhi, 93 p. (1967).

[3] Bindra, O. S., and Udeaan, A. S., Efficacy of malathion as a protectant for wheat grains. Pesticides, 7 2 (1973) 11-4.

[4] Sidhu, T. S., Studies on the toxicity and residual effectiveness of malathion as a grain protectant for stored maize. Unpub. M.Sc. thesis, Dept. Zoo.-Entom., Punjab agric. Univ., Ludhiana, 109p. (1971).

[5] Wilson, H. R., Amar Singh, Bindra, O. S., and Everett, T. R., Rural wheat storage in Ludhiana district, Punjab. The Ford Found., New Delhi, Pt I 28p., Pt II 11p., 3 appendices, (1970).

[6] Udeaan, A. S., and Bindra, O. S., Malathion residues in wheat grains in relation to dosage applied, storage period and receptacle used for storage. Bull. Grain Technol. 19 1 (1971), 13-9.

[7] Bindra, O. S., and Sidhu, T. S., Dissipation of malathion residues on maize grain in relation to dosage, storage conditions and baking. J. Fd Sci. & Technol. 9 1 (1972), 29-32.
[8] Udeaan, A. S., and Bindra, O. S., Malathion residues in different fractions of treated food grains and their finished derivatives. SPRA*. (1971), 61-7.
[9] Godavari Bai, S., Krishnamurthy, K., and Majumder, S. K., Studies on malathion for stored-product insect control, Pt 1: Persistence and residual toxicity of malathion on wheat-flour and its efficacy in controlling *Tribolium castaneum* (Hbst.), Publ. Hlth & Sanit. 2 2 (1960), 12-5.
[10] Lockwood, L. M., Organophosphate pesticides for use as grain protectants in India: degradation of their residue during milling and cooking of cereal grains. Unpub. Ph.D. Disser., Dept. Grain Sci. & Indust., Kansas State Univ., Manhattan, Kansas. (1973).
[11] Bindra, O. S., Harcharan Singh, Amar Singh, and Mavi, G. S., Modified machine for application of grain protectants. Agric. & Agro-indust. J. 4 1 (1971), 1-5.
[12] Udeaan, A. S., Chawla, R. P., and Kalra, R. L., Some observations on the variation in insecticidal deposit on treated wheat grains. J. Fd. Sci. & Technol. 11 1 (1974), 17-9.
[13] Bindra, O. S., Kalra, R. L., Deshmukh, S. N. and Teginder Singh, Effect of the consumption of malathion-treated wheat on the blood cholinesterase level. Abstr. 43rd An. Sess., nat. Acad. Sci. India, Jodhpur, Oct. 20-22, 1973.
[14] Bhatia, S. K., Yadav, T. D., and Mookherjee, P. B., Malathion resistance in *Tribolium castaneum* (Herbst) in India. J. Stored Prod. Res. 7 (1971) 227-30.
[15] Chawla, R. P., and Bindra, O. S., Toxicity of some safer insecticides to stored-grain pests and residues of potential grain protectants. Indian J. Pl Pro. 1 1 (1973) 57-9.
[16] Chawla, R. P., and Bindra, O. S., Residues of some promising grain protectants on stored wheat. SPRA*. (1971) 68-74.
[17] Thomas, Jacob, Studies on the evaluation of iodophenphos as a grain protectant for stored maize. Unpub. M.Sc. Thesis, Dept Entomol., Punjab agric. Univ., Ludhiana. (1974).

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*Bindra, O. S., and Kalra, R. L. (Ed.), Progress and Problems in Pesticide Residue Analysis, (Proc. Symp., 18-19 Nov. 1971, Ludhiana) 1973. Punjab agric. Univ., Ludhiana & Indian Counc. agric. Res., New Delhi, 336 p.