PESTICIDE RESIDUES OF POTENTIAL PROTECTANTS OF GRAIN

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ABSTRACT: Residue data were obtained during a 12-month period from hard winter wheat, shelled corn and sorghum grain treated with candidate grain protectant materials. The patterns of degradation were compared with those from the standard treatment of malathion. Acetellic(R) and Reldan(R) residues were not as greatly influenced as malathion and accothion by a high moisture content of the grain at the time of treatment.

The recovery of malathion residue was significantly greater from grain treated with a dust formulation than from grain treated with an emulsion when the moisture content of the grain was 12.5% or lower.

Pesticides are very important in today's world. Adequate assurance against the ravages of stored-grain insects is needed for the safe storage of reserve food stocks as well as for the storage of grain on the farm and in transit, through terminal storages and processing plants on their way to the consumer. The benefits of pest control are relatively easy to define, but losses caused when controls are not practiced cannot be readily delineated. The grain industry relies upon the use of chemicals for the control of existing insect infestations and for the prevention of insect damage to uninfested grain.

There is wide-spread agreement that the maintenance of reserve food stocks is wise and necessary on a world-wide basis. These food stocks must be protected by the use of vapor toxicants, residual materials and grain protectants. In view of the fact that there is a definite, documented need of substitutes for malathion, pyrethrum and lindane, because of the resistance to these materials being developed by many species of insects, research on chemical control methods is being continued. We cannot foresee, in the immediate future, any substitute methods to replace the control of stored-product insects by chemicals.

The work in chemical control that we are conducting at the Manhattan, Kansas laboratory is mission-oriented and trichotomous in nature involving (1) extensive laboratory research in the evaluation of the activity of candidate materials, (2) intermediate type, small-bin (free-choice) studies with formulations and rates of application derived from the laboratory work, and (3) supportive field research. The limits of each are not clearly defined and certain phases may overlap where needed to understand multi-factored characteristics of the materials under study. Our primary objectives are to develop "adaptive controls," that is, controls that will be acceptable throughout the world trade channels.

At the present time, we are working with a number of chemicals of low mammalian toxicity that show promise as broad-spectrum substitutes for those materials now recommended as grain protectants and residual sprays. I will now discuss the patterns of residue degradation of 4 formulations, namely Reldan(R), Actellic(R), and accothion emulsions and a malathion-Kenite 2-1(R) dust, which were equal to or more effective as grain protectants against insect damage than a malathion emulsion spray during 12-month small-bin storage studies with 12.5% moisture corn and wheat and 17.6% moisture sorghum grain. Grain was stored in 5 ft^3 cardboard barrels at (4 bu/barrel) 26.7 ± 1°C and 60 ± 5% RH in 17' x 22' rooms. At least four replicates of each treatment were tested. The high moisture sorghum was treated with 0.2% propionic acid directly before application of the insecticides to inhibit fungal growth. Samples for analysis were taken with a non-compartmented grain probe.

Table 1 shows the residue levels found on wheat during a 12-month storage period. Malathion and accothion emulsion residues degraded gradually at about the same rate over the 12-month storage period. Reldan residues degraded gradually but at a lower rate than those of the malathion emulsion. Actellic residues degraded in an erratic pattern. Malathion residues degraded more slowly on wheat treated with the dust formulation than on wheat treated with the emulsion. These latter results are similar to residue data obtained from the dust treatments on 12.5% moisture corn (Table 2).

TABLE 1. Average residues in ppm on 12.5% moisture wheat stored in 5 ft^3 bins.[a]

Insecticide formulation	Intended dosage	Hours 24	Post-treatment periods, Months 1	3	6	9	12
Emulsions							
Malathion	10.4	8.6	5.2	3.8	3.0	2.0	1.4
Reldan	6.3	6.0	4.8	3.8	2.7	1.8	1.6
Accothion	8.3	6.2	4.9	3.4	2.6	1.6	1.3
Actellic	7.8	6.5	6.1	5.6	6.2	4.9	5.4
Dusts[b]							
Malathion	10.4	8.2	6.7	4.6	3.9	2.6	2.0
"	10.4	8.8	7.3	5.3	4.0	2.8	2.3
"	10.4	8.5	7.0	5.0	3.9	2.7	2.3

[a]Stored at 26.7 ± 1.1°C.

[b]Three separate replicated tests -- 60 pounds of Kenite 2-1 containing 1 pint of 57% malathion EC per 1,000 bushels.

Malathion, and Reldan residues showed similar degradation patterns on corn and wheat but accothion residues degraded more rapidly on the corn. After 12 months' storage, 38% of the initial Acetellic

TABLE 2. Average residues in ppm on 12.5% moisture corn stored in 5 ft^3 bins.[a]

Insecticide formulation	Intended dosage	Post-treatment periods Hours 24	Months 1	3	6	9	12
Emulsions							
Malathion[b]	11.2	9.0	6.1	4.0	3.2	2.2	1.4
Malathion[b]	11.2	7.3	4.5	4.1	2.0	2.3	1.6
Reldan	6.7	6.1	5.0	4.0	2.3	1.8	1.4
Accothion	8.9	6.2	4.8	3.4	1.7	1.1	.8
Actellic	8.4	7.9	6.3	4.5	4.1	3.4	3.0
Dusts[c]							
Malathion	11.2	7.7	6.8	5.8	5.3	3.8	3.0
"	11.2	8.4	7.7	5.0	4.6	4.7	4.4
"	11.2	8.8	8.5	6.0	6.4	3.3	2.8

[a]Stored at 26.7 ± 1.1°C.
[b]Separate replicated tests
[c]Three separate replicated tests - 60 pounds of Kenite 2-1 containing 1 pint of 57% malathion EC per 1,000 bushels.

deposit remained on the treated corn.

Table 3 shows that the malathion residues degraded very rapidly on the 17.6% moisture sorghum. A loss in effectiveness of this treatment against rice weevil, red and confused flour beetle

TABLE 3. Average residues in ppm on 17.6% moisture sorghum stored in 5 ft^3 bins.[a]

Insecticide formulation	Intended dosage	Post-treatment periods Hours 24	Months 1	3	6	9	12
Emulsions							
Malathion	16.7	13.4	3.8	1.6	1.5	.9	.8
Reldan	6.7	6.0	5.0	3.5	2.6	1.9	1.6
Accothion	8.9	6.1	4.0	3.0	2.0	1.3	1.1
Actellic	8.4	7.5	6.5	4.3	3.8	3.8	3.7
Dusts[b]							
Malathion	11.2	9.1	.5	.3	.2	.2	.1
"	11.2	7.5	.5	.3	.3	.2	.1

[a]Propionic acid applied at the rate of .2% by weight of sorghum grain to prevent spoilage. Stored at 26.7 ± 1°C.
[b]Two separate replicated tests - 60 pounds of Kenite 2-1 containing 1 pint of 57% malathion EC per 1,000 bushels.

and lesser grain borer infestations was noted during the second month of storage. Nearly 50% of the initial deposit of Actellic remained after 12 months' storage. Reldan and accothion residues degraded gradually with ca. 27 and 18%, respectively, of the initial deposits remaining after 12 months. The malathion in the dust formulation degraded very rapidly during the first month of storage.

Further studies are underway with these and other insecticides with corn and wheat at varying moisture contents. Residues in Reldan and Actellic emulsion treatments are not degrading rapidly even under high moisture levels. Dust formulations of these materials have also been very effective against insects in the studies completed to date.

Residues of Actellic on grain are degraded and detoxified by hydrolysis of the ester side chain. Reldan is relatively stable to hydrolysis, but rate of chemical breakdown is accelerated by increasing or decreasing pH. The degradation products of both materials resulting in stored grain are considered safe and no adverse effects on the environment have been observed.