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Degradation of Malathion in Corn, Wheat, and Sorghum Grain of High Moisture Content[1]

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ABSTRACT

Malathion residues on hard winter wheat, shelled corn, and sorghum grain (15% moisture content) were found to degrade from 93.3, 90.6, and 74.3% 24 h after treatment to 61, 37, and 31%, respectively, after 28 days storage.

Malathion is the principal insecticide used to protect stored grains. The influence of hybrid, foreign material, moisture content, and storage temperature on the rate malathion residue disappears from sorghum grain has been determined (Kadoum and LaHue 1969), as have rates of malathion penetration and degradation during a 6 mo storage following a 10 ppm application to 14% moisture corn, wheat, and sorghum grain (Kadoum and LaHue 1974) and the effect of the biological activity of sorghum with 14% moisture on malathion degradation rate (Kadoum and LaHue 1972).

In cereal technology, the respiration of cleaned, undamaged, and uninfested grain is considered minor in degradation of malathion when the moisture content of protected grains is under 14%. Wheat's critical moisture content is ca. 14.6%; corn's 14.2%; and sorghum grain's 14.3% (Bailey 1940). Strong and Sbur (1960) found that moisture content of ca. 14% was critical for persistent biological effectiveness of malathion. Since data were incomplete on malathion residue disappearance from grain with moisture values above 14.6%, we determined the amounts remaining on corn, wheat, and sorghum, containing 15.0±.2% moisture, at selected intervals up to 28 days after treatment with 10 ppm AI.

MATERIALS AND METHODS.—*Adjusting Moisture Content.*—Grains were conditioned to 15.0±.2% moisture content by adding distilled water. Following each moisture adjustment, they were left 2 wk at 26.7°C to equilibrate. Adding water or drying at 40–44°C in a forced-air laboratory dryer was repeated until the desired moisture content was obtained within +0.2% in each lot. Moisture contents were determined with a Steinlite 512RC moisture tester.

Malathion Treatment.—Premium grade malathion EC containing 57% malathion (5.0 lb AI/gal) was diluted with distilled water to make an emulsion for 1-ml applications to 100 g of grain to deposit 10 ppm AI, as detailed by Kadoum and LaHue (1969). One-qt mason jars containing 100 g of grain were used. After treatment, samples were stored at 26.7°C and 60% RH for aging. Five replications of each sample were analyzed.

Samples were taken within 1 h for the initial analysis, then 1, 3, 6, 9, 12, and 24 h, at daily intervals for 14 days, then on days 21 and 28 post-treatment. Each treated 100-g sample was divided into 5–20 g subsamples for analysis.

Extraction and Clean-up Procedures.—Malathion residues were extracted and cleaned for gas chromatographic analysis using a modification of Kadoum's (1969) procedures. Twenty-g subsamples were blended with 100 ml of distilled acetone in a covered Sorvall Omnimixer at top speed for 2 minutes. The acetone extract was filtered and transferred with the aid of 50 ml of acetone wash to a 250-ml round-bottom flask. The filtered acetone extract was concentrated to 2–3 ml under vacuum. The residue was transferred, using 10 ml hexane, to a 250-ml separatory funnel containing 100 ml water. The funnel was shaken vigorously for 30 seconds. After the 2 layers separated, the lower, aqueous layer was drawn off and discarded. The upper hexane layer was partitioned with 80% acetonitrile in water for analysis (Kadoum 1968).

Gas Chromatographic Analysis.—An electron capture detector was used to analyze malathion residue under these operating conditions: column—6 ft glass column of 3% DC-11 on 60-mesh silinized Gas Chrom. P; carrier gas—nitrogen, 36 ml/min; temperature—column 200°C, detector cell 220°C; injector 240°C; volume injected—4 μl of the extract in hexane.

RESULTS AND DISCUSSION.—Table 1 shows malathion residue found during the 28-day study. Chemical analyses immediately after treatment showed that 10.1, 9.4, and 9.5 ppm AI were initially deposited on the sorghum, wheat, and corn, respectively. During the 1st 24 h, only 5.7 and 9.4% of the residue disappeared on sorghum and wheat contrasted with 25.7% from corn.

During the next 28 days, 69.1, 63.0, and 39.1% of

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Table 1.—Malathion residues on sorghum grain, corn, and wheat after 10 ppm applications.[a,b]

Interval after application	Residue recovered (ppm) from		
	Sorghum	Wheat	Corn
Hours			
0	10.1±0.26[c]	9.4±0.13	9.5±0.18
1	9.9±0.06	8.9±0.07	8.5±0.06
3	9.7±0.05	8.6±0.07	7.5±0.06
6	9.6±0.07	8.6±0.07	7.5±0.06
9	9.6±0.04	8.5±0.05	7.2±0.04
12	9.5±0.04	8.5±0.05	7.1±0.09
24	9.4±0.04	8.5±0.08	7.1±0.05
Days			
1	9.4±0.42	8.5±0.07	7.1±0.04
2	8.9±0.10	7.6±0.08	6.4±0.04
3	8.5±0.21	7.1±0.08	5.9±0.08
4	8.1±0.29	6.6±0.12	5.5±0.06
5	7.9±0.14	6.3±0.11	5.3±0.12
6	7.7±0.11	6.1±0.09	5.1±0.07
7	7.5±0.27	5.9±0.08	4.9±0.06
8	7.4±0.12	5.7±0.05	4.8±0.06
9	7.3±0.05	5.6±0.07	4.7±0.04
10	7.2±0.08	5.4±0.08	4.6±0.07
11	7.1±0.08	5.3±0.07	4.5±0.07
12	7.0±0.07	5.2±0.06	4.4±0.07
13	7.0±0.12	5.1±0.07	4.3±0.07
14	6.9±0.07	4.9±0.10	4.2±0.06
21	6.5±0.21	4.1±0.09	3.5±0.12
28	6.2±0.07	3.5±0.12	2.9±0.10

[a] Stored at 26.7±1.1°C.
[b] Averages of 5 replications.
[c] Mean deviation.

the initial deposits disappeared from corn, wheat, and sorghum, respectively.

We had previously found (Kadoum and LaHue 1969) that increased moisture content of the grain greatly enhanced malathion breakdown. Recent studies with malathion and 14% grain, sorghum retained 72.1% of malathion residue after a 1 mo storage compared with 47.7 and 45.1% for corn and wheat, respectively (Kadoum and LaHue 1974). Those percentages were based on residue measured 24 h after it was applied. Apparently higher moisture content does not accelerate residue degradation on sorghum as much as it does on corn or wheat.

These results confirm and extend previous observations that increased moisture content of grain enhances malathion degradation and that the rate of degradation is greater on corn and wheat than on sorghum (Kadoum and LaHue 1969, 1974). Biological activity of live sorghum kernels enhances breakdown, hence, age of grain, moisture content and physical characteristics may influence retention.

The data presented here can be used effectively to establish rates of application to grain harvested and stored under adverse moisture conditions.

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