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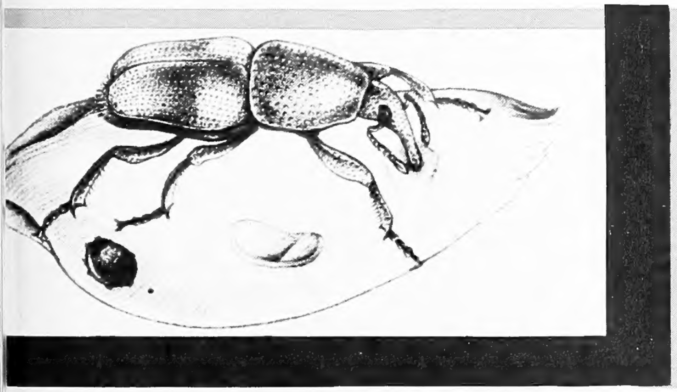
Tests with Malathion and Methoxychlor Protective Treatments for Shelled Corn Stored in Metal Bins in the Southeast



Marketing Research Division
Agricultural Marketing Service
U. S. DEPARTMENT OF AGRICULTURE

PREFACE

This report presents results of field tests with two of the five materials tested in an exploratory manner and reported in Marketing Research Report 272.

These reports are part of a broad program of research designed to reduce the cost of marketing farm products, including the cost of preventing insect infestation in stored grain.

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TESTS WITH MALATHION AND METHOXYCHLOR PROTECTIVE TREATMENTS FOR SHELLED CORN STORED IN METAL BINS IN THE SOUTHEAST

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SUMMARY

A study of the effectiveness of malathion emulsion sprays and methoxychlor dusts in protecting shelled corn from insect attack during an 8-month storage period in the Southeast was carried on from May 1957 to February 1958. Malathion emulsion sprays were applied at 5, 10, 15, and 20 parts per million (p. p. m.) of technical premium grade malathion; and methoxychlor dusts were applied at 12.5, 25, 50, and 100 p. p. m. of technical methoxychlor. At the time of treatment, the corn averaged 13.76 percent of moisture, test weight was 56.95 pounds per bushel, and 16.9 percent of the kernels were damaged.

The percentage of damaged kernels increased in all treatments during the 8-month storage period; however, less kernel damage was noted in the 10, 15, and 20 p. p. m. malathion treatments than in the other treatments. There were decreases in the test weights in all cases. The decrease in the corn treated with 20 p. p. m. of technical malathion, however, was slight. Results of examinations of the probe samples showed that malathion, at all rates of application used, was superior to the methoxychlor treatments. Examination of eight 1-gallon samples from the mass and a 1-gallon sample from the surface of each bin also showed fewer insects in the malathion treatments than in the methoxychlor-treated corn.

Residues of malathion and methoxychlor remaining at the termination of the test were determined by the Chemical Unit of the Section at Savannah, Ga.

INTRODUCTION

Exploratory studies were made at Tifton, Ga., from 1951 through 1957, to develop information on the feasibility of protective treatments for stored Southern-grown corn. The results of laboratory-scale tests with five materials were presented in Marketing Research Report 272, "Treatments for the Protection of Stored Southern-Grown Corn from Rice Weevil Attack--Exploratory Tests." Three of the five materials were selected for further study under commercial storage conditions. This report presents the results of further evaluation studies made in 1957 and 1958 with two of the selected materials, malathion and methoxychlor.

Under usual conditions, the need for protection against insect infestation during storage extends from the time of harvest until May or June of the following year. The usual infestation pattern starts out with some rice weevil infestation present in the corn at harvest; this continues to develop in the warm fall weather. Insect activity is reduced during the winter, and the level of infestation remains about constant until March, when rising temperatures stimulate increased activity. During April, May, and June, infestations by the rice weevil and other stored-grain insects, such as bran bugs and the Indian-meal moth, develop rapidly. In order to increase the severity of insect attack, and for reasons of availability of corn and bins, the tests reported here were begun in May when conditions were optimum for infestation, and continued until the following February.

[1] This laboratory is a field station of the Stored-Product Insects Section, Biological Sciences Branch, Marketing Research Division, Agricultural Marketing Service, U. S. Department of Agriculture. Aklee Cagle, W. O. Farmer, Huey Hall, and Gordon Pearman, of the laboratory staff, assisted in these studies.

PROCEDURE

The tests were conducted with shelled corn stored in 500-bushel circular metal bins. The corn was from the 1954 crop of a weevil-susceptible, white variety which had been stored as ear corn in farm cribs until used in this experiment. At the start of the tests, the average moisture content was 13.76 percent; the average test weight was 56.95 pounds per bushel; 16.9 percent of the kernels were insect damaged. There was a natural infestation of rice weevils that had been established during previous storage. The corn was supplied by the Commodity Credit Corporation from local supplies taken over in payment of price support loans. The approximately 1,900 bushels of shelled corn available were divided into nine lots of 212 bushels each. Twelve bushels were removed from each of these lots for small-scale supplemental tests.

Four 200-bushel lots of shelled corn were treated with a malathion protective spray; four were treated with a methoxychlor protective dust; and one lot was held as an untreated check. The dilute malathion spray was prepared from a 57 percent emulsifiable concentrate (premium grade) and applied at a rate of 5 gallons per 1,000 bushels at concentrations to give dosage rates of 5, 10, 15, and 20 p.p.m. of malathion. The spray was applied with a gear-pump sprayer operating at 30 pounds per square inch. The nozzle was mounted on the grain elevator used to transfer the corn into the metal bins, and the spray was directed onto the moving stream of shelled corn. The flow of shelled corn over the elevator was held constant so that the spray application was uniform and accurate.

The methoxychlor dust was formulated from a commercially available 10-percent dust and additional inert clay carrier. Four concentrations were prepared so that the application rate was constant at 56 pounds per 1,000 bushels, but the dosage rates of methoxychlor were varied to give 12.5, 25, 50, and 100 p.p.m. The dust was applied to the moving stream of shelled corn in the elevator in a uniform manner with a hand-powered rotary duster.

The degree of protection given by the various concentrations of each material was determined on the basis of (1) insect populations present in probe samples taken at various intervals during the storage period and in 1-gallon samples collected at the termination of the tests, and (2) the increase in the percentage of insect-damaged kernels and decrease in test weight. The amount and potency of actual deposits of the insecticides remaining on the shelled corn were checked by chemical analysis of the samples taken at the termination of the test and by bioassay tests of a portion of the same samples in which test insects were confined in the samples for at least four days. The resulting mortality was recorded.

Six probe samples (1,500 grams) were taken at each examination, four from the top to the bottom of the shelled corn in the four quadrants, and two from near the center. These samples were combined and sifted to determine the number and species of insects present. Nine 1-gallon samples were taken when the tests were terminated, one from the surface layer, and eight from the bulk of the shelled corn as it was removed from each metal bin. The number and species of insects in each sample were recorded, as well as the moisture content and test weight.

The 12 bushels, which were removed from each lot before treatment for use in the small-scale supplementary tests, were stored in drum-type experimental bins described in MRR 272. Four replications of 3 bushels each were set up for each of the eight treatments. These were sampled and evaluated in parallel with the large bin tests to establish the correlation between the two methods of testing. One probe sample was taken from top to bottom of each replication at each examination, and a 1-gallon sample was collected from each replication at the termination of the test.

Since Indian-meal moth infestations in surface areas of binned, shelled corn is an acute problem in the Southeast as well as elsewhere, observations were made of the effectiveness of each protective treatment in preventing such infestations. Counts of adult moths on the grain surface and in the overspace of each metal bin were made on the same dates that the probe samples were taken and also on August 5th and January 16th. It is generally agreed that the surface area of shelled corn may need to be sprayed periodically with the same formulation used in applying the protective treatments, but information on the inhibiting influence of the original protective treatment is also needed.

RESULTS

The numbers of insects found in the six combined probe samples (1,500 grams) from each metal bin on August 14, September 5, October 1, November 1 and 18, and December 20 are given in table 1. The numbers of insects, per 1-gallon sample of shelled corn, found when the tests were terminated are given in table 2. The moisture content, loss in test weight, insecticidal residues present, mortality produced in bioassay tests, and the increase in the percentage of insect-damaged kernels when the study was terminated are given in table 3. The comparable data, recorded in the small-scale supplementary tests in drum-type bins, are presented in tables 4 and 5. The moth populations observed in each metal bin are recorded in table 6.

EVALUATION OF DATA

From the data in table 1, it can be noted that all of the malathion protective treatments suppressed insect infestations to a degree during the storage period on the basis of insects found in the probe samples. However, when the more extensive examination was made at the termination of the test, there was a distinct gradation in the level of insect populations in direct relation to the dosage rate, with the 20 p. p. m. rate causing almost total elimination of the insects (table 2). It will be noted that the suppression of "other insects" (flour beetles, moth larvae, flat grain beetles, cadelles, and corn sap beetles, in order of abundance) in the methoxychlor and check samples was more pronounced than the suppression of the rice weevil. This was probably due to the initial kernel infestation of rice weevils in the bulk corn which kept emerging, whereas the bran bugs were presumed to invade the bins from outside sources and start infestations.

The degree of protection, based on the limitation of further increase in the percentage of insect-damaged kernels and loss in test weight also shows a similar gradation directly related to the dosage rate of malathion (table 3). Since practically no live insects were found in the 20-p. p. m. treatment during and at the termination of storage, the increase in insect-damaged kernels in that treatment is attributed to the emergence of rice weevil larvae from already infested kernels in the early part of the storage period. The small decrease in the moisture content of the 20-p. p. m. treatment could account for part of the decrease in test weight.

The positive potency of the insecticidal deposit of malathion in the bioassay tests conducted with samples taken at the termination of the storage period (table 3) further substantiates the excellent suppression of insects and protection against damage in the 20-p. p. m. treatment. The results obtained in studies from the drum-type bin tests closely parallel those of the metal bin tests (tables 4 and 5). The high level of mortality obtained in bioassay studies in the 15- and 20-p. p. m. treatments showed a satisfactory insecticidal deposit at the termination of the tests (table 5).

The methoxychlor treatments did not suppress insect infestations during the storage according to the data in table 1. On the basis of the insect counts at the termination of the storage period (table 2), there was a gradation in effectiveness as the dosage rate increased. However, the 100-p. p. m. treatment showed an increase in the percentage of insect-damaged kernels intermediate between the 5- and 10-p. p. m. malathion treatments and a greater loss in test weight than either; in fact, it approached the weight loss in the check (table 3). The insecticidal deposit of methoxychlor was rather low at the termination of the storage period, and only a low level of mortality was produced in the test insects used in bioassay studies. Insect counts at the termination of the supplemental tests in drum-type bins showed a gradation in effectiveness as the dosage rate increased (table 4).

Evidence of the lower insecticidal deposits at the termination of the supplemental tests is shown by the low level of mortality in the test insects used in bioassay studies (table 5). These results lead to the conclusion that dosage rates of 100 p. p. m. or less of methoxychlor are not sufficient to give good protection under practical conditions in the Southeast.

The results with methoxychlor are in agreement with the tests reported in series F of MRR 272, where lots of corn with a self-contained infestation at the start of storage were not protected with dosage rates up to 100 p. p. m.

The small-scale supplementary tests in the drum-type bins (tables 4 and 5) showed results closely paralleling those in the metal bins and indicated that the results from the small-scale tests can probably be used to good advantage for an intermediate phase of exploratory testing in a research program to develop protective treatments for shelled corn stored in larger bulks.

The data in table 6 indicate that a malathion protective treatment may be effective in suppressing surface infestations by the Indian-meal moth and related species for one storage season, or with only one supplemental application of the same formulation to the surface. It should be recognized that the treatments in these tests were applied in May, so that they had not aged as long by the time moth activity was at its peak as they would in normal practice, where the moth activity would be greatest in the late spring following an early fall application. The methoxychlor treatments had little effect on the moth infestations.

FINDINGS

In these practical scale tests, which follow up exploratory tests reported in MRR 272, the malathion protective treatment, at a dosage rate of 20 p. p. m., gave excellent protection to stored shelled corn in the Southeast. The gradations in effectiveness with dosage rates of 15, 10, and 5 p. p. m. were in logical sequence in relation to the 20-p. p. m. rate. In addition, the original protective treatment suppressed the development of moth infestations on the surface layer of the shelled corn and indicated that perhaps no supplemental application of the formulation to the surface, or only one, would be needed to prevent such infestations.

Methoxychlor protective dusts were much less effective and demonstrated that effective protection in the Southeast would require dosage rates above 100 p. p. m.

TABLE 1.--Insects found in 1,500 grams of shelled corn from six probe samples each of treated and check lots on various dates between August and December, 1957

Protective treatment and dosage rate	August 14		September 5		October 1		November 1		November 18		December 20	
	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others
Malathion spray	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
5 p.p.m.......	0	0	0	0	0	0	0	2	0	1	0	1
10 p.p.m.......	0	0	0	0	0	0	1	0	2	0	0	0
15 p.p.m.......	0	0	0	0	0	0	0	0	0	0	1	0
20 p.p.m.......	0	0	0	2	0	0	0	10	0	0	0	0
Methoxychlor dust												
12.5 p.p.m.......	0	15	0	26	4	35	0	14	10	14	2	18
25 p.p.m.......	4	16	0	16	1	21	10	12	7	12	3	4
50 p.p.m.......	4	4	0	0	2	4	10	7	25	6	10	5
100 p.p.m.......	1	5	0	0	2	0	5	0	5	0	14	0
Check..............	8	35	0	23	10	41	12	38	0	16	4	13

TABLE 2.--Insects per gallon in samples of shelled corn at the termination of tests, February 1958

Protective treatment, dosage rate, and location of sample	Rice weevils	Other insects
Malathion spray		
5 p.p.m.	*Number*	*Number*
Surface layer[1]	71	11
Grain bulk[2]	92.4	4
10 p.p.m.		
Surface layer	27	0
Grain bulk	43.8	.1
15 p.p.m.		
Surface layer	5	0
Grain bulk	34.5	.3
20 p.p.m.		
Surface layer	2	0
Grain bulk	1	.4
Methoxychlor dust		
12.5 p.p.m.		
Surface layer	176	105
Grain bulk	140.8	52
25 p.p.m.		
Surface layer	96	25
Grain bulk	145.4	39
50 p.p.m.		
Surface layer	31	38
Grain bulk	88	20.4
100 p.p.m.		
Surface layer	19	14
Grain bulk	26	2.6
Check		
Surface layer	138	91
Grain bulk	74.1	47.4

[1] One replication.
[2] Average of 8 replications.

TABLE 3.--Condition of samples from the treated and check lots of shelled corn at the termination of tests, February 1958

Protective treatment and dosage rate	Moisture content	Loss in test weight	Insecticidal residue	Mortality in bioassay tests	Increase in percentage of insect-damaged kernels
Malathion spray	*Percent*	*Pounds*	*P.p.m.*	*Percent*	*Percent*
5 p.p.m.	14.03	2.9	4.1	27.9	18.1
10 p.p.m.	13.58	1.95	5.75	77.5	12.4
15 p.p.m.	13.24	1.75	7.25	95.4	11.4
20 p.p.m.	12.91	.85	7.5	96.5	7.9
Methoxychlor dust					
12.5 p.p.m.	13.81	3.25	1.8	6.3	21.2
25 p.p.m.	13.91	2.85	3.25	9.1	21.9
50 p.p.m.	13.67	2.15	7.03	13.4	18.6
100 p.p.m.	14.01	3.25	10.7	10	16.6
Check	13.65	3.45	--	8.5	37.9

TABLE 4.--Insects found in probe samples of shelled corn taken during storage and in 1-gallon samples at the termination of supplementary small-scale tests in drum-type bins

Protective treatment and dosage rate	Insects found in probe samples collected on--								Terminal samples	
	October 1		November 1		November 21		December 20			
	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others	Rice weevils	Others
Malathion spray	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
5 p.p.m.	0	0	3	0	3	0.25	2	0	3.25	2.5
10 p.p.m.	0	0	.25	0	.25	0	.75	0	.25	3.25
15 p.p.m.	0	0	.25	0	.25	0	.25	0	.25	2.25
20 p.p.m.	0	0	.25	0	.5	0	1	0	.5	.75
Methoxychlor dust										
12.5 p.p.m.	6.75	.5	6	1	51.25	.25	8	1.75	161.5	5.25
25 p.p.m.	16.25	1	14.5	0	46.25	1.5	14.25	0	127.25	4.25
50 p.p.m.	14.25	2	20.5	2.25	106.25	.5	29.25	0	61.25	2.5
100 p.p.m.	15.75	0	5	0	56.25	0	8	0	36.25	1.25
Check	31.25	3.25	45.25	6.75	88.75	.25	43	1.75	207.5	11

TABLE 5.--Condition of treated and check samples of shelled corn at the termination of supplementary small-scale tests conducted in drum-type bins

Protective treatment and dosage rate	Loss in test weight	Mortality in bioassay tests	Increase in percentage of insect-damaged kernels
Malathion spray	*Pounds*	*Percent*	*Percent*
5 p.p.m..................	4.35	40.3	21.1
10 p.p.m..................	3.85	81	19.1
15 p.p.m..................	2.15	93.7	13.1
20 p.p.m..................	3.35	98.8	14.1
Methoxychlor dust			
12.5 p.p.m..................	5.55	11.8	61.1
25 p.p.m..................	5.25	13.1	46.1
50 p.p.m..................	4.75	11.8	35.1
100 p.p.m..................	4.65	25.2	26.1
Check........................	5.55	12.2	50.1

TABLE 6.--Adult moths observed on the grain surface and above the surface of shelled corn stored in metal bins on various dates

Protective treatment and dosage rate	Moths observed on--								
	Aug. 5	Aug. 14	Sept. 5	Oct. 1	Nov. 1	Nov. 18	Dec. 20	Jan. 16	Total
Malathion spray	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
5 p.p.m.............	15	10	15	60	70	80	40	32	322
10 p.p.m.............	2	4	10	25	50	60	12	0	163
15 p.p.m.............	8	15	40	20	30	25	5	0	143
20 p.p.m.............	12	15	15	25	30	25	5	0	127
Methoxychlor dust									
12.5 p.p.m.............	40	40	250	200	700	800	500	110	2,640
25 p.p.m.............	50	50	200	250	300	200	200	60	1,310
50 p.p.m.............	25	30	200	400	300	500	300	76	1,831
100 p.p.m.............	18	20	175	500	1,000	1,000	300	85	3,098
Check.....................	200	150	250	250	1,000	1,000	200	154	3,204

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