Preference of *Tribolium castaneum* for Wheat Containing Various Percentages of Dockage[1,2]

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ABSTRACT

Tests conducted in preference chambers containing clean wheat and wheat with various percentages of dockage showed that *T. castaneum* (Herbst) exhibited preference for grain with high dockage content. The number of insects present in each of the samples was directly proportional to the percentage of dockage in the grain.

The problem of insect infestation in clean grain is not generally considered to be as great as that in unclean grain. The content of dockage may directly influence the infestation of grain by insects, and the location of the dockage may influence the distribution of free-crawling species of insects in the grain mass. Cotton and Frankenfeld (1945) showed that, within limits studied, grain moisture, grain temperature, and dockage all affected the fecundity of the confused flour beetle, *Tribolium confusum* Jacquelin duVal. The present study is a continuation of the earlier work.

In many instances, grain is turned and cleaned after it has been in storage a year or more. Opinions are mixed as to whether or not such cleaning is worth the additional cost and effort. Cleaning of the grain before storage might well be an economically sound means of controlling certain insects and maintaining the quality of grain. The popular concept of maintaining weight by retaining the dockage is a problem which must be confronted. If the United States is to develop foreign markets for its surplus grains destined for human consumption, quality must be maintained at the highest level possible.

Tests are currently being conducted at the Stored-Grain Insects Laboratory at Manhattan, Kansas, to investigate the ecological aspect of varying amounts of dockage in wheat on the biology and distribution of stored-grain insects. The primary objective of this study

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[2] For the purpose of this test, dockage was considered to be equal parts by weight of wheat dust, wheat chaff, and broken kernels which would pass through a No. 8 dockage sieve, which has equilateral triangle perforations in which an inscribed circle is 0.089 in. in diameter.

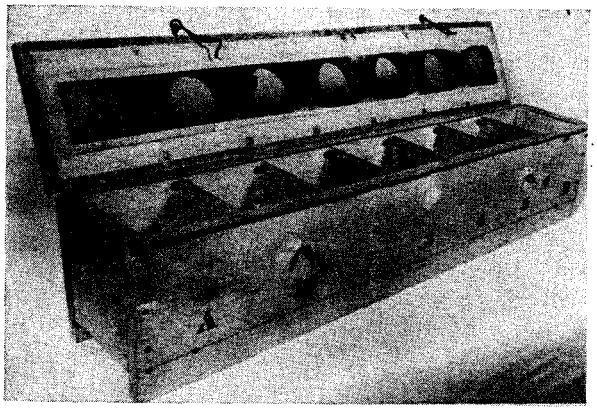

FIG. 1.—Test chamber used in studies of preference of *Tribolium castaneum* for wheat containing various percentages of dockage.

was to determine the habitational preference of the red flour beetle adult, *Tribolium castaneum* (Herbst), among samples of wheat containing various percentages of dockage. A more thorough understanding of the effects of dockage in grain should result in improved insect-control measures.

METHODS.—This test was conducted under controlled conditions in a laboratory maintained at a temperature of 80° ± 2° F, and 60 ± 2% RH.

The wheat used was cleaned of all dockage by passing the grain through a seed cleaner.

The wheat dust and wheat chaff were obtained from an elevator where they had been removed from wheat going into storage. The chaff was screened thoroughly to remove as much dust as possible. The broken kernels were obtained by coarse grinding the small kernels removed from the original wheat.

The test chambers were constructed of 1-in. lumber (Fig. 1). Metal slides could be inserted to form 7 compartments, each 5 in. long, 5½ in. wide, and 5½ in. deep. The 2 end compartments, used as buffer zones, were slightly less than 5 in. long. The lids of the chambers were fastened on with 3 hinges and 2 screen-door hooks and were weather stripped for tightness. Three-in. holes centered over each compartment, were covered on the inside with 60-mesh screen. A 1¾ in. hole was in the bottom center of each compartment. Rubber stoppers were removed to discharge the grain and test insects for screening and counting. The chambers were numbered 1 through 30 and the compartments were marked A, 1, 2, 3, 4, 5, and B for identification.

A holding rack was designed and constructed to permit maximum circulation of air around the test chambers.

The 7 compartments of the 25 test chambers were loaded with 1000 g of clean wheat and dockage as follows:

Type of dockage and percentage by weight:

	Compartment number						
	A	1	2	3	4	5	B
	%	%	%	%	%	%	%
Wheat dust	0	0	0.1	1.5	3.0	4.5	4.5
Wheat chaff	0	0	0.1	1.5	3.0	4.5	4.5
Broken kernels	0	0	0.1	1.5	3.0	4.5	4.5
Clean wheat	100	100	99.7	95.5	91.0	86.5	86.5
Total dockage	0	0	0.3	4.5	9.0	13.5	13.5

The compartments of the remaining 5 chambers were loaded with clean wheat and were used as performance checks.

The test chambers were left undisturbed 4 days to equalize the grain temperature throughout all test chambers. The moisture content of the clean wheat throughout the test period was 12.5%. The same mixture of grain was placed in the buffer zones, compartments A and B, as was placed in the compartments next to them. This buffer zone at each end of the chamber eliminated the possibility that the chamber corners might influence the habitational preference of the insects. The insects found in the buffer zones were disregarded when the results were evaluated.

Fifty *T. castaneum* adults were introduced at the center of the wheat and/or wheat and dockage mixture in each compartment. A glass funnel was inserted into the wheat, and the insects were shaken down the funnel. They were placed well under the surface of the wheat so that the metal partitions could be removed and the test chamber closed before the insects could escape.

The test insects were confined to the chambers 7 days. The chambers were then opened and the metal partitions reinserted to prevent commingling of wheat and dockage and last-minute migration of test insects. The contents of each compartment were removed and screened. The insects were removed and the number recorded. The

Table 1.—The minimum, maximum, and average number of *T. castaneum* adults recovered from the various gradients of dockage in 25 test chambers after a 1-week exposure period, and the minimum, maximum, and average number of progeny developed after an incubation period of 8 weeks.

Compartment number	Dockage (%)	*T. castaneum* recovered per 1000 g			Progeny developed[a] per 1000 g		
		Range			Range		
		Min. (no.)	Max. (no.)	Avg. (no.)	Min. (no.)	Max. (no.)	Avg. (no.)
A	0.0	0	18	7.3	—	—	—
1	.0	0	9	3.3	0	24	3.8
2	.3	2	18	6.6	0	36	10.0
3	4.5	48	110	63.4	352	764	548.2
4	9.0	50	127	88.8	568	1176	814.8
5	13.5	71	113	98.2	780	1304	1035.3
B	13.5	41	101	73.4	—	—	—

[a] Based on 24 replicates.

Table 2.—The minimum, maximum, and average number of *T. castaneum* adults recovered from all clean wheat in 5 test chambers after a 1-week exposure period, and the minimum, maximum, and average number of progeny that had developed after an incubation period of 8 weeks.

Compartment number	*T. castaneum* recovered per 1000 g			Progeny developed per 1000 g		
	Range			Range		
	Min. (no.)	Max. (no.)	Avg. (no.)	Min. (no.)	Max. (no.)	Avg. (no.)
A	29	76	52.4	—	—	—
1	25	51	38.2	12	64	28.0
2	24	33	29.2	8	60	27.2
3	23	34	28.4	4	60	24.8
4	24	35	27.8	12	48	22.4
5	28	33	30.8	8	32	17.6
B	85	156	131.0	—	—	—

mixture from each compartment was then divided with a Boerner Seed Divider[3], and ¼ (250 g), was retained for the fecundity test. Each sample was placed in a 1-qt jar, with the cap upside down to prevent an airtight seal. After 8 weeks, the contents of each jar were screened and the numbers of progeny that had completed their life cycle were recorded. The number of progeny in each sample was multiplied by 4 to show theoretically the number that would have been found in each compartment of 1000 g.

RESULTS.—The results of these tests are summarized in Tables 1 and 2. The average and the range in numbers of insects recovered from various gradients of dockage at 7 days and at 8 weeks after the test was started are presented in Table 1. Of the test insects, 97% were recovered from the 25 test chambers, 23% of them in the buffer zones which included clean and high dockage-content wheat. Greater numbers were in the buffer zone in wheat containing 13.5% dockage. Excluding the buffer compartments an average of 3.3 adults were recovered in the clean wheat, as compared with 98.2 in the wheat containing 13.5% dockage. The largest increase occurred when the dockage was increased from 0.3 to 4.5%. This increase was reflected in the fecundity test. An average of only 10 progeny developed in the 0.3% dockage, as compared with an average of 543.2 in the wheat containing 4.5% dockage.

The average and range in numbers of insects recovered from the clean wheat at 7 days and at 8 weeks after the test was started are presented in Table 2. Recovery was made of 96% of the test insects placed in the 5 test chambers. The buffer zones, which also contained clean wheat, contained 54% of the insects recovered.

Many factors may influence the buildup of insect populations in stored grain. Some of these are moisture content, humidity, temperature, and kind of dockage. Of special interest would be an investigation to determine the effect when different percentages of specific kinds of dockage such as broken kernels, chaff, and wheat dust are used separately in wheat.

The results in Table 2 show about a 1:1 ratio of adults recovered to progeny produced. Both adults and progeny were fairly evenly distributed among the several compartments when there was no dockage present. This compares with the small number in compartment 1 (clean grain) of the chambers with various gradients of dockage, in which the insects were free to move out of the clean wheat into wheat with a higher percentage of dockage. However, the influence of dockage is amplified in Table 1 by the large number of progeny produced in relation to the number of adults recovered. In the test chambers that contained all clean wheat, the total number of progeny was appreciably lower than in the chambers that contained dockage along with the wheat.

DISCUSSION AND CONCLUSIONS.—Wheat with dockage is preferred by *T. castaneum*. The fecundity of the insects increased rapidly as the percentage of dockage was increased. With this accelerated increase in progeny, dirty grain can be expected to become highly infested and go out of condition much more quickly than clean grain.

REFERENCE CITED

Cotton R. T., and J. C. Frankenfeld. 1945. Protecting stored seed from insect attack. U. S. Dep. Agr. E-677. 15 p.

[3] The use of trade names is for identification purposes only and does not constitute endorsement by the U. S. Department of Agriculture.

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