AN INVESTIGATION OF THE EFFECTIVENESS OF REMOVING "HIDDEN" INFESTATION IN WHEAT BY MEANS OF THE ENTOLETER SCOURER-ASPIRATOR

by

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INTRODUCTION

Controlling insect infestation in wheat and flour has been of major importance to the flour milling industry for a great many years, but especially so the past few years. Federal legislation has made millers realize that control of insect infestation is a necessity. For example, Wagner (10) has stated that operative millers must take cognizance of the responsibilities imposed by the Food and Drug statutes and evaluate their obligations to their consuming public. The seriousness of the infestation problem and the demand for immediate control measures is further emphasized by the recent conferences among members of the Millers' National Federation and officials of several federal governmental agencies.

The Food and Drug Administration has established rigid standards for the purity of flour and mill products, and freedom from contamination is one of the requirements. According to Larrick (9), the law does not seek to exact the impossible; however, it does expect the miller to make use of new improvements and to strive constantly to improve the sanitary quality of their product. To insure that clean, wholesome flour reaches the consumer in perfect condition should be the essential aim of the milling industry. The industry will then be safeguarding against the economic loss of having flour condemned due to contamination.

Considerable effort has been made by millers to meet the sanitation standards formulated by the Food and Drug Administration. Even with all the sanitary practices now employed by mills to eliminate insect infestation, it has not been possible to attain the desired standards. To help the situation, Mr. J. O. Clarke (2), Director of Research, Federal Security Administration, explained the program being initiated by the Food and Drug Administration cooperating with the United States Department of Agriculture, the flour milling industry, and the wheat producers to determine the facts in regard to the infestation of wheat, and the degree to which the infestation can be prevented or removed by proper handling, storage and milling practices.

Clarke (2) further stated that insect infestation in wheat may be evidenced by the presence in the product of live or dead adult insects which can be easily seen by visual examination. There may also occur in wheat a type of internal infestation which may not be readily apparent on visual examination. This type of infestation occurs when an insect egg is deposited in or on the berry and the insect in its early stage of development feeds within the kernel of the berry. This is known as "hidden" infestation.

When infestation in the wheat is not removed in the milling process, it will pass into the flour in the form of insect fragments. These can only be detected and evaluated by laboratory methods. The miller has been able to eliminate all extraneous surface infestation by the use of modern, efficient cleaning practices. However, wheat containing "hidden" insect infestation requires an extensive cleaning process which has not been completely perfected.

There is urgent need for a method of destroying all insect infestation in wheat. The method would have to break open the infested kernels thus exposing the internal insect contamination for removal from the wheat before it undergoes the first milling process. In this manner, the accumulation of insect fragments, larva and eggs in the mill streams and machinery would be eliminated. Under present operating conditions it has not been possible to avoid having some insect contamination present in the finished product if the original wheat was infested. Hence, the problem of eliminating insect contamination demands greater efficiency in wheat cleaning processes than have been available.

OBJECT

The purpose of this research was to investigate and determine the effectiveness of the Entoleter Scourer-Aspirator[1] as a means of breaking open infested wheat kernels, and removing the insects, whole or fragmented, by aspiration. Also the intensity of the impact action of different rotor and liner combinations was evaluated by determining the amount of breakage in infested and sound kernels. The efficiency of the aspirating system in removing insect fragments and undesirable material was measured.

1/ "Entoleter" is the registered trademark of the Safety Car Heating and Lighting Co., Inc.

REVIEW OF LITERATURE

Entoleter Infestation Destroyer Experiments

A great deal of experimentation has been conducted by the Entoleter Division, The Safety Car Heating and Lighting Company, Incorporated, to find effective infestation control measures that could be applied to the wheat cleaning operation. According to Dodds (4), the Entoleter infestation destroyer proved to be a simple means of continuous control applicable to many of the sources of infestation in mills. This was confirmed by Cotton and Frankenfeld (3) in their tests with an Entoleter operating at a speed of 1750 revolutions per minute under conditions of abnormally heavy infestation in untempered wheat. They found that 99.66 per cent of free living insects were destroyed. It was believed that the use of a higher speed would result in 100 per cent kill regardless of the amount of infestation, but the breakage of dry wheat would be excessive. Flour yield was not affected when wheat subjected to this process was milled.

It is reported that when using tempered wheat, the Entoleter rotor could revolve at 3500 revolutions per minute without breaking up sound wheat. The process destroyed all external and internal infestation, knocked loose crease dirt, beeswing and whiskers, and broke up undesirable "weevil cut" wheat kernels. The insect fragments, dirt, beeswing, whiskers and other foreign matter were removed by aspiration.

Eliminating Insect Fragments

According to Wagner (10) it has been proved that modern mill machinery will not remove insect fragments from flour. Insects in infested wheat will break up during the passage between the rolls and can not be separated from the flour.

Dodds (4) reported that the solution of removing insect fragments from flour resolves itself into some method of exposing the insects inside the kernel and removing them ahead of the break rolls. He found this could be accomplished by the impact action of the Entoleter which broke open the infested kernels. Aspiration ahead of the rolls removed the infestation. Tests were conducted on heavily infested clean, tempered wheat. A reduction of 67.7 per cent in insect fragment count was obtained by aspirating the wheat with a laboratory aspirator, which removed 0.68 per cent of the stock after the Entoleter impact action. The same wheat subjected to the Entoleter impact action in another test was aspirated with a commercial aspirator which removed 0.46 per cent of the wheat stock. The reduction in insect fragments was 62.5 per cent. It is apparent that not all insect fragments were removed.

In microscopical examination of samples of dust collector and aspirator tip stock following Entoleter impact operation of infested, clean tempered wheat, the evidence found indicated clearly that the filth count in all cases was so high that it would be hazardous to do otherwise than divert all of the aspirtor tip stock to feed.

According to Durham (5) impact machines can be expected to destroy a large part of the insect life in wheat; however, the machines would not do so 100 per cent of the time for all stages of insect development.

The review of the literature shows that, in general, not much information is available concerning the effectiveness of different types of cleaning equipment for destroying and removing "hidden" infestation from wheat. At present, the most efficient machine for controlling infestation is the Entoleter Scourer-Aspirator. However, there is no information on the results obtained by using different rotor and liner combinations in the Entoleter on different stages of insect development.

METHODS AND MATERIALS

Variables of Impact Action

The effectiveness of impact action as a means of killing "hidden" infestation in wheat, and the amount of breakage of the wheat depends upon the following variables.

(1) Moisture content of the grain

(2) Type of grain such as

   (a) Hard or soft wheat

   (b) Test weight

   (c) Age

(3) Amount of insect infestation

(4) Stage of insect development

(5) Rate of feed to machine

(6) Type of rotor and liner in machine

(7) Speed of rotor

No attempt was made in this investigation to study all variables because time would not permit. The results reported are the study of varying only the stage of insect development in the kernels, and the type of rotor and liner combination employed in the machine.

Entoleter Scourer-Aspirator Installation

The Entoleter Scourer-Aspirator installation is shown in Plates I and II. The installation consisted of the following parts.

(1) A feed hopper with a capacity of 250 pounds for holding the sample above the Entoleter Scourer-Aspirator.

(2) A Merchen Powerless Feeder to supply a uniform rate of feed, 30 pounds per minute.

(3) An Entoleter Scourer-Aspirator with a capacity of 45 pounds per minute. The motor was a 1.5 horsepower General Electric induction motor, capable of developing 3450 revolutions per minute at full load. The following rotor and liner combinations were used.

(a) 12-inch peg rotor with smooth liner

(b) 13-inch blade rotor with 54-tooth corrugated liner with 20° vertical angle corrugations

(c) 14-inch peg rotor with smooth liner

(d) 14-inch peg rotor, without top plate, with smooth liner

(4) An expansion chamber with about four square feet effective expansion area for the settling of heavy particles of the aspirated material.

(5) An exhaust fan, a Day Company No. 20 type G exhauster with a three horsepower Westinghouse induction motor capable of 1730 revolutions per minute at full load, and capable of delivering 1000 cubic feet of air a minute.

(6) A dust collector, a Day Company No. 40 Design 1 Dual-Clone.

(7) An eight-inch Manning, Maxwell and Moore water manometer, type 1370 U Gauge.

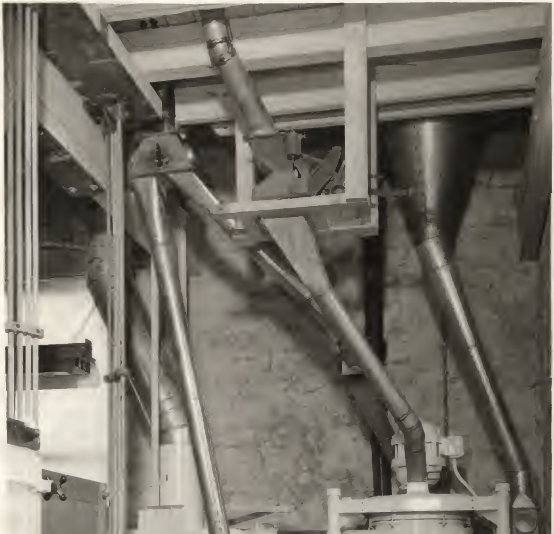
(8) Four "A" valves installed in the flow to permit the sampling of the different streams.

The flow of the Entoleter Scourer-Aspirator system employed in this investigation is shown on Plate III. The sample of wheat to be run was placed in the holding bin. A Merchen Powerless Feeder governed the rate of feed to the Entoleter Scourer-Aspirator. The wheat was fed into one inlet only. After being subjected to the impact and aspirating action, the wheat was caught directly beneath the machine by turning an "A" valve. The aspirated material removed from the wheat stream was drawn through the expansion chamber where the heavier particles settled and the lighter stock lifted into the dust collector. Due to the location of the fan on the clean outlet side of the dust collector, it was necessary to have an air lock in the dust outlet of the dust collector to prevent the air intake

EXPLANATION OF PLATE I

The Entoleter Scourer-Aspirator installation showing the Merchen Powerless feeder, the Entoleter Scourer-Aspirator, and the expansion chamber.

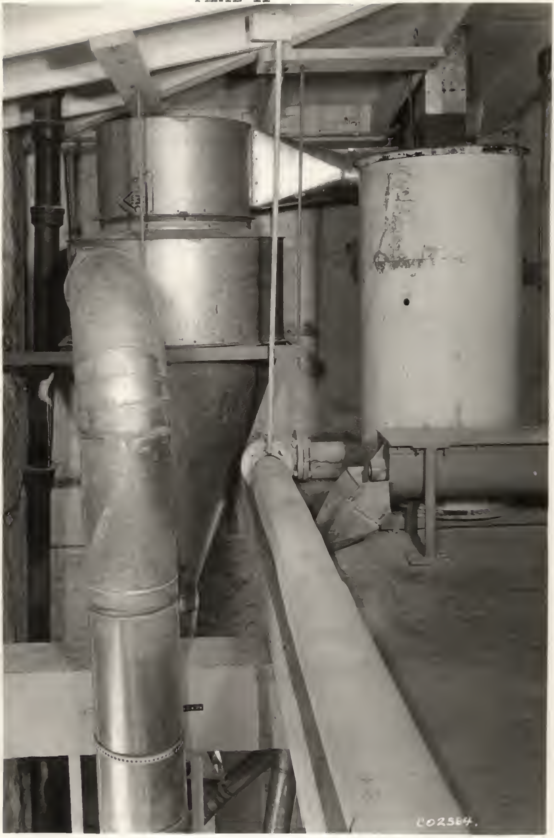
PLATE I



EXPLANATION OF PLATE II

The Entoleter Scourer-Aspirator installation showing a Day Company dust collector and a Day Company exhaust fan located behind the feed hopper.

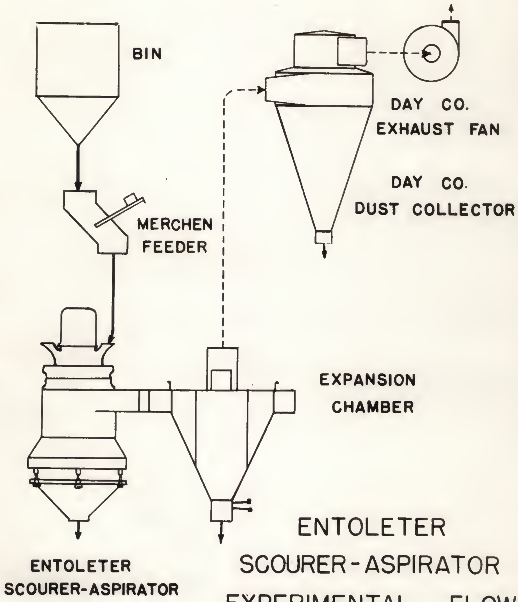
PLATE II



EXPLANATION OF PLATE III

The flow of the Entoleter Scourer-Aspirator employed in this investigation.

PLATE III



ENTOLETER
SCOURER-ASPIRATOR
EXPERIMENTAL FLOW

at that point, and thereby destroy the usefulness of the collector.

Theory of Utility

The Entoleter Scourer-Aspirator is employed as the last cleaning operation before the wheat goes to the mill proper. Three main reasons for this are as follows:

(1) Less breakage of sound kernels occurs in tempered wheat;

(2) Broken kernels and endosperm will not be exposed to further breaking, attrition or removal by washers, disc separators, scourers, or other cleaning equipment; and

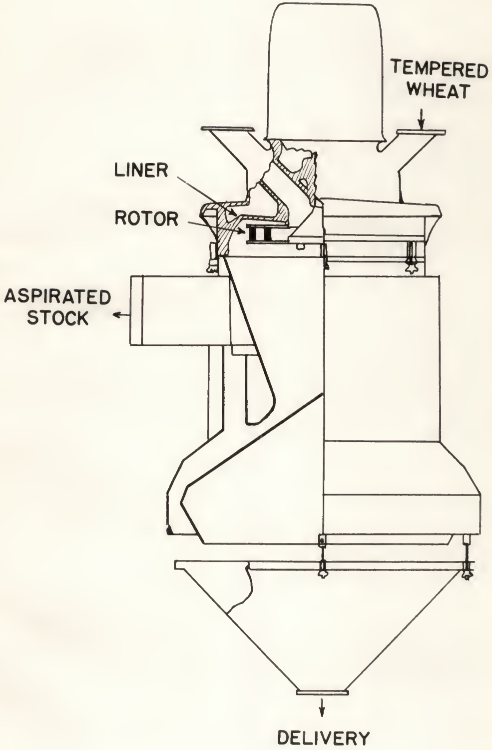
(3) Broken kernels or pieces of endosperm will have already been thoroughly cleaned and can be processed if desired. This may be accomplished by using an exceptionally strong aspiration and recovering the tip stock, although this is not generally recommended.

A cross sectional view of the Entoleter Scourer-Aspirator is shown on Plate IV. The wheat enters the machine at the center of a disc or rotor, and strikes a conical hub attached to the shaft rotating the disc. Centrifugal force forces the wheat stock through concentric rows of impactors. The material leaves the rotor at a high tangential velocity accompanied by strong air currents. Upon leaving the rotor the stock strikes an outer case or liner, and is discharged to the scouring and aspirating cylinder below.

EXPLANATION OF PLATE IV

A cross sectional view of the Entoleter Scourer-Aspirator.

PLATE IV



The velocity of the heavier stock is reduced by the scouring action while the lighter material is carried by air currents down the distributing cone and out the exhaust. The heavier stock is equally distributed in a thin layer over the cone. As the stock falls from the outer edge of the cone, a current of air passes through the material lifting the lighter particles out the exhaust.

According to Hibbs, Shellenberger and Pence (8), the breaking action produced by impact is accomplished in the following manner. As the wheat kernels strike the center of the rotating disc, they are deflected toward the rotating impactors. When struck by the impactors, the center of impact is a relatively small portion of the entire wheat kernel. Therefore, lines of compression and tension will be formed and the particle will break, if force is great enough, along lines of least resistance. The structural strength of the bran and endosprem will affect the nature of the breakage.

Utility of Expansion Chamber

The expansion chamber employed for settling the heavier aspirated particles operates in the following manner. Alden (1) states that the essential operating principle of the chamber requires that the conveying velocity be dissipated in order to promote dust settlement. Each particle must be acted upon by some force which does not act upon the entraining air or acts upon it in a different or lesser degree so that the particle will move from the conveying air stream to a region where the conveying forces are less effective or non-existent or counteracted by more powerful forces of retention. In all separators the particle must move through some distance laterally across the air stream. At its destination it must be entrapped in some manner so that it can not again enter the cleaned air. In a settling chamber, the separating force is gravity.

In the Entoleter Scourer-Aspirator installation, an expansion or settling chamber was installed in the air duct next to the Entoleter Scourer-Aspirator. The principle of this arrangement was to apply a heavy suction to pull out some good material, then drop out the heavier particles by reducing the air velocity to about 200 feet per minute in the expansion chamber, sending the remaining light material on to the dust collector.

The material retained in the expansion chamber could be classified and sent on to the mill. This principle can be used in the pre-break operation where the objective is to break all the kernels at the crease by impact and remove the light bran particles, crease dirt and other small size material by aspiration. The heavier material removed would settle in the expansion chamber, and the lighter undesirable matter sent on to the dust collector. The good, heavier stock would then be classified and sent to the mill.

Preparation of Wheat Samples

Two samples of No. 1 Dark Hard Red Winter wheat were used in this study. One sample contained 14.5 per cent protein and had a test weight of 62.1 pounds per bushel. The other sample contained 11.5 per cent protein and had a test weight of 59.6 pounds per bushel. The results were reported on a 14 per cent moisture basis. Both wheats were free from insect infestation.

In cooperation with the U.S.D.A. Bureau of Entomology and Plant Quarantine, Manhattan, Kansas, and under the supervision of entomologist Mr. J. C. Frankenfeld, wheat samples were prepared with a known per cent of infestation. 15-pound lots of wheat were infested with rice weevil (Sitophilus oryza L.). During a period of seven days, weevils were permitted to deposit eggs in the wheat kernels. The per cent of "hidden" infestation was determined by a staining technique developed by Frankenfeld (6).

The test consists of treating samples of grain with a dye which stains the egg plugs and weevil punctures. The eggs and immature stages of the rice weevil, hidden within the kernels of wheat are invisible to the naked eye and can not be detected by ordinary inspection methods. Before the female insect deposits her egg in the wheat kernel, she first drills a hole into the kernel surface. After depositing her egg she seals the cavity with a gelatinous secretion, which hardens and serves as a protective plug. It is this plug which has an affinity for the dye which makes the infested kernels easily detected. The plugs will remain on the wheat kernel throughout the development of the insect within the kernel. Hence, in examining the stained wheat under a magnifying glass, the dark red plugs are observed, and provide an accurate measure of infestation.

A constant percent of "hidden" infestation was maintained throughout the experiment. This was accomplished by blending a certain amount of a known per cent of infested wheat with another portion of uninfested wheat to produce 60-pound lots containing five per cent infested kernels. All lots of wheat were tempered to 16 per cent moisture for 24 hours.

Four different stages of insect development were employed in addition to the control. The control sample was sound uninfested wheat. The stages of development were as follows:

(1) Egg stage

(2) One-week-old larva stage

(3) Three-week-old larva stage

(4) Adult stage as it begins to emerge from the kernel.

Experimental Procedure

In conducting tests with the Entoleter Scourer-Aspirator, 10 samples of about 1000 grams were caught during each test run on 60-pound lots of wheat. From these samples, 10 10-gram samples were examined to determine the number of whole kernels, the weight of the whole kernels, and the weight of the broken material. Thus an accurate measurement of breakage was obtained. Ten subsamples of 100 whole kernels were examined by the stain technique to determine the average number of infested kernels per 500 kernels not broken by the impact action.

To determine if all infestation had been killed, three 100-gram samples of each test run were placed in clean bottles, tightly covered with muslin. The bottles were placed in a room with conditions of 80 per cent relative humidity and 80 degrees F. The bottles were checked two weeks after the maturity date of the insects for live infestation. The delay in checking for live infestation after the maturity period was found necessary in that insects not killed by the impact action were retarded in their growth and took longer to emerge from the kernels.

To determine the amount of insect fragments remaining in the wheat subjected to the Entoleter Scourer-Aspirator operation, a 500-gram sample of the wheat stock was ground in a Wiley grinder through a sieve with perforations about five millimeters in diameter. Four 50-gram subsamples were taken from each 500-gram sample and an analysis for fragments was made by the Gier, Wilbur and Miller (7) technique. However, due to the presence of excessive bran chips in the granular material, several modifications were necessary in using a differential stain for identifying the insect fragments in the ground wheat stock. The modified procedure as developed by the

Department of Entomology, Kansas State College, was as follows:

(1) Weigh 50 grams of the material and place in a 1000-milliliter beaker.

(2) Add 500 milliliters of distilled water, mix well and bring mixture slowly to a boil. Continue boiling for 15 minutes; stir constantly.

(3) Cool mixture to 50 degrees Centigrade.

(4) Add one gram of pancreatin and stir well. Allow to digest for 10 minutes; digestion frees the insect fragments.

(5) Add 10 milliliters of one-normal potassium hydroxide to adjust the pH level to approximately 8.5.

(6) Add 10 milliliters of Azure I stain and mix thoroughly; allow to stand for 15 minutes.

(7) Pour mixture into a 2000-milliliter Wildman trap flask. (2000-milliliter Erlenmeyer flask equipped with a trapping rod and stopper.)

(8) Add 150 to 200 milliliters of 60 per cent ethyl alcohol and mix well; allow to stand for 10 minutes.

(9) Add 35 milliliters of petroleum ether; mix well.

(10) Add tap water to bring floating mass up to just inside the neck of the flask.

(11) Allow to stand for 30 minutes.

(12) Add enough water to bring the floating mass far enough into the neck of the flask so as to allow the trapping stopper to include the entire layer in the neck of the flask.

(13) Trap off contents in neck of flask into a 500-

milliliter beaker. Wash trapping section and rod thoroughly with water to insure that all fragments are transferred to beaker. Discard remaining material in flask.

(14) Evaporate petroleum ether by placing beaker in a water bath at 75 degrees Centigrade.

(15) Add 1.5 milliliter of Azure I stain and 0.5 milliliter of Methylene Blue stain. Mix well and allow to cool for 20 minutes.

(16) Transfer solution to a separatory funnel.

(17) Add 35 milliliters of petroleum ether and mix thoroughly; remove cork at intervals to permit the escape of gases formed by mixing.

(18) Wash three times with approximately 500 milliliters of tap water. Allow to stand to permit fragments to refloat in the ether layer.

(19) Drain off as much water as possible without disturbing the ether layer.

(20) After third washing transfer material to a Buchner funnel. Allow liquids to pass through a filter paper; wash all extracted material to the filter paper.

(21) Wash filter paper with approximately three to five milliliters of acetone and allow to dry.

(22) Remove filter paper and place it in a Petri dish in which a thin layer of mineral oil has been added.

(23) Examine microscopically.

The stained fragments may be differentiated by their green color contrasting with the blue bran particles.

A sieving analysis was made on the 10 1000-gram samples taken during each test to provide a description of the breakage of wheat according to relative particle size. The samples were sifted in an automatic rotary sifter. Two sieves were used--a No. 8W and a No. 10W.

The material removed by aspiration which settled either in the expansion chamber or the dust collector was weighed and recorded separately for each run. This provided another means of determining the intensity of impact action and the effect of insect development on the amount of fine material produced. The greater the percentage of fine material, the greater the amount of material that should be removed by aspiration.

Measurements of power consumption of the Entoleter motor operating under different conditions were recorded. Also measurements of the static pressure of the air being conveyed in the aspirating duct were taken. The location of the static tube was seven inches beyond the aspirator outlet.

Statistical Methods

The measurements taken were studied by means of analysis of variance and t-test to evaluate properly the effects of sampling variation.

The t-test was used to determine least significant differences even though it is recognized that the technique does not lead to exact probability statements. However, with so few means in any one group, it was felt that the information gained by their use outweighed the slight loss in exactness of probability statements.

EXPERIMENTAL RESULTS

The results reported deal with the efficiency of different combinations of rotors and liners as a means of breaking infested kernels to expose the infestation in order that it may be removed by aspiration. The efficiency of the combined impact and aspirating action is determined by the number of unbroken infested kernels, the size of the fragment count, and the number of insects that reach maturity after being subjected to the Entoleter Scourer-Aspirator operation.

Breakage Analysis

An analysis of the per cent of breakage, produced by different rotor and liner combinations on sound and infested kernels is given in Table 2. Within each rotor and liner combination employed, there was very slight variation in the amount of breakage of wheat containing different stages of insect development. Therefore, the percentages of breakage are averages of the total breakage obtained on all stages of insect development.

Measurements of the per cent of breakage produced by the impact action of different rotor and liner combinations are recorded in Table 1. The 13-inch blade rotor with corrugated liner fractured 81.8 per cent of the kernels, while the 14-inch peg rotor with smooth liner fractured 45.1 per cent of the

Table 1. Measurements of the percent of breakage produced by the impact action of different rotor and liner combinations.

Stage of Infestation	13" Blade R, Corr. L.		14" Peg R, Smooth L.		14" Peg R[1], Smooth L.		12" Peg R[2], Smooth L.		12" Peg R, Smooth L.	
Uninfested	80.4	81.4	43.9	51.5	31.8	30.8	15.3	20.6	26.7	25.2
	81.3	83.3	42.9	46.5	32.4	32.6	17.8	22.9	18.2	22.5
	82.2	80.9	45.0	44.6	31.3	32.1	17.8	21.9	22.3	21.1
	79.5	80.7	45.1	44.0	33.9	31.9	22.0	20.0	21.3	20.5
	80.9	82.5	43.7	44.1	33.4	32.2	23.0	24.2	21.3	23.4
Egg	84.3	83.1	45.4	44.3	33.2	36.2	21.4	22.5	27.4	19.9
	83.6	84.1	46.1	40.9	36.9	28.5	21.7	26.4	21.8	23.4
	82.3	81.2	43.0	45.4	31.8	34.9	25.2	22.7	21.4	25.6
	81.1	81.1	40.8	41.0	32.0	30.2	21.5	24.8	21.1	25.6
	82.4	80.2	43.7	40.5	31.0	36.2	20.5	19.7	19.5	21.6
One-week-old larva	77.7	79.9	50.7	47.0	36.4	32.9	14.1	14.2	12.8	15.1
	80.7	82.5	51.4	45.4	30.7	31.6	17.1	15.8	16.3	17.2
	81.5	83.7	47.6	50.5	32.2	35.7	14.4	15.7	14.2	15.3
	78.0	80.8	45.8	46.0	34.5	31.3	13.3	13.6	13.2	13.9
	83.3	82.5	47.5	45.3	34.7	32.5	19.5	18.8	14.1	16.3
Three-week-old larva	84.0	85.0	45.4	46.7	34.2	32.5	16.5	16.3	15.6	17.0
	80.4	80.9	44.9	52.7	39.8	44.4	19.4	17.8	15.4	19.1
	84.2	80.9	49.5	49.4	41.4	40.1	19.3	17.0	18.7	14.1
	84.5	80.3	46.2	47.9	36.1	38.8	17.8	18.5	16.4	15.1
	83.7	81.8	45.4	44.9	38.9	47.2	16.5	20.7	17.2	17.0
Adult	84.7	81.4	44.4	42.1	35.7	34.7	16.6	19.6	18.1	19.0
	81.3	81.9	49.1	37.6	43.1	34.2	17.5	22.5	20.7	23.7
	84.1	80.4	42.2	41.1	36.4	39.9	19.6	19.3	22.4	22.1
	81.1	80.6	40.5	41.6	35.3	37.2	20.5	21.8	20.1	21.8
	82.7	80.7	38.8	42.6	34.5	35.6	17.6	16.7	21.1	22.1

1/ Rotor with top plate removed
2/ Without aspiration

Table 2. Analysis of variance of breakage produced by different rotor and liner combinations on four stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	4	33,154.70[3]
Stage of development	4	43.60[2]
Interaction - TxS	16	83.94[1]
Observations	225	5.20
Total	249	

1/ Highly significant
2/ Not significant
3/ Highly significant

kernels. The 14-inch peg rotor without the top plate broke 34.9 per cent of the kernels, while the 12-inch peg rotor with smooth liner fractured only 19.5 per cent of the kernels. Aspiration was not employed in one series of tests using the 12-inch peg rotor with smooth liner. This combination broke up only 19.2 per cent of the kernels. A graph showing these results is shown in Fig. 1.

Sieving Analysis

Data from the sieving analysis of the 1000-gram samples of wheat subjected to the Entoleter Scourer-Aspirator operation are given in Tables 3, 4 and 5. There was a highly significant difference produced by the different combinations of rotors and liners employed. The variation in the stage of insect development showed no important trend. This is illustrated in Figs.

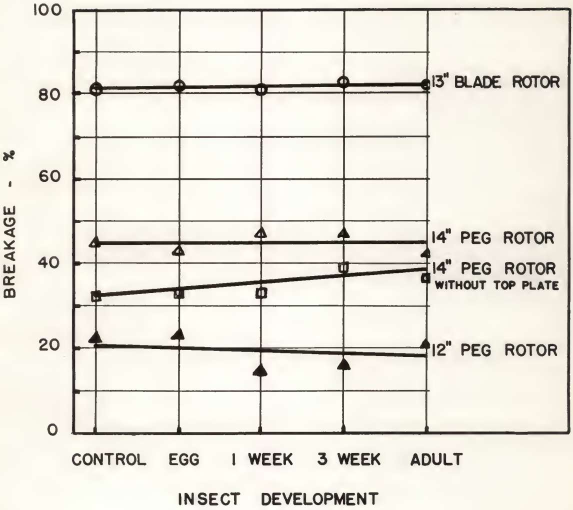


Fig. 1. Effect of the impact action of different rotor and liner combinations in breaking wheat containing different stages of infestation.

Table 3. Percent of wheat stock removed by a No. 8W sieve.

Stage of Infestation	13" Blade R, Corr. L.		14" Peg R, Smooth L.		14" Peg R[1], Smooth L.		12" Peg R[2], Smooth L.		12" Peg R, Smooth L.	
Uninfested	40.7	38.7	61.1	61.4	86.8	85.3	91.0	90.7	90.8	90.4
	38.6	39.7	59.8	61.0	85.4	86.2	90.5	90.0	89.9	89.8
	39.0	39.9	58.0	60.0	87.2	85.4	90.0	90.9	90.4	90.7
	39.4	39.2	60.7	59.5	85.8	85.3	90.9	91.3	90.5	91.0
	40.3	39.6	60.8	59.9	86.4	84.9	89.9	90.8	90.6	90.3
Egg	38.4	38.6	56.9	57.4	85.6	85.5	90.6	90.8	89.6	90.3
	37.7	38.8	58.6	57.6	85.4	85.1	90.6	90.5	90.2	90.0
	38.4	38.2	57.8	58.5	85.2	85.2	91.0	90.0	90.7	89.9
	37.6	38.2	56.4	58.0	85.5	85.1	91.0	90.2	90.2	91.0
	38.0	39.1	57.8	57.4	85.3	84.9	90.3	90.6	90.0	90.7
One-week-old larva	38.2	38.3	53.9	57.3	84.2	83.9	93.5	93.3	94.0	93.3
	37.9	38.2	56.8	54.0	83.5	84.4	93.0	92.7	93.8	93.1
	37.6	36.8	46.7	55.6	84.5	83.9	92.5	92.6	93.6	93.4
	38.7	36.5	55.2	54.1	83.8	84.4	93.4	93.4	93.3	93.0
	37.8	38.7	56.0	54.8	84.2	83.1	92.3	93.3	93.4	93.4
Three-week-old larva	38.0	36.4	55.0	55.8	81.7	81.8	92.2	90.2	92.4	92.2
	38.0	37.3	56.5	56.4	82.2	81.7	92.2	92.0	92.1	92.4
	38.2	38.2	56.0	55.4	81.1	80.5	92.0	92.0	92.5	92.2
	36.7	37.4	56.6	55.7	82.1	81.6	92.1	91.6	92.5	92.4
	36.2	35.8	54.0	56.4	81.8	81.9	92.1	92.5	92.6	92.2
Adult	36.3	37.8	59.3	60.6	84.7	84.8	91.4	90.4	91.8	91.8
	36.0	38.2	58.0	57.8	85.3	85.3	91.3	90.9	91.6	91.7
	38.2	38.0	58.8	60.0	85.1	85.4	91.5	90.0	91.5	91.8
	37.7	38.6	57.0	59.6	84.0	85.0	91.7	90.8	91.8	92.0
	37.6	38.2	58.4	59.9	84.8	84.7	90.5	91.8	91.7	91.6

1/ Rotor with top plate removed
2/ Without aspiration

Table 4. Percent of wheat stock removed by a No. 10W sieve.

Stage of Infestation	13" Blade R, Corr. L.		14" Peg R, Smooth L.		14" Peg R[1], Smooth L.		12" Peg R[2], Smooth L.		12" Peg R, Smooth L.	
Uninfested	36.1	36.9	31.6	31.4	10.2	12.5	7.5	7.6	7.9	8.2
	38.1	37.3	32.4	31.8	11.7	10.7	7.8	7.6	8.5	8.7
	37.7	37.9	33.7	32.5	9.9	11.6	7.5	7.9	8.2	7.9
	37.6	37.6	31.9	32.7	11.1	11.5	7.5	7.0	8.1	7.7
	37.3	38.5	32.0	32.4	10.6	12.2	8.1	7.5	8.2	8.2
Egg	37.9	37.4	34.6	34.4	11.2	11.3	7.6	7.4	8.9	8.6
	38.5	38.5	34.2	33.2	11.6	11.6	7.5	7.6	8.4	8.3
	38.3	38.1	33.4	34.3	11.4	11.5	7.5	7.9	8.0	8.6
	37.8	38.1	34.6	34.8	11.3	11.7	7.5	7.9	8.1	8.6
	38.2	38.2	33.7	33.5	11.5	11.9	7.8	7.6	8.4	7.7
One-week-old larva	38.7	38.3	35.9	33.4	12.1	12.4	5.5	5.7	5.3	5.9
	38.0	38.8	34.0	35.5	12.7	12.2	5.8	6.0	5.5	6.0
	38.4	37.5	33.3	34.9	12.0	12.3	6.3	6.0	5.6	5.8
	38.8	38.4	35.0	35.4	12.4	11.8	5.6	5.6	5.9	6.1
	38.1	38.0	34.3	35.5	12.3	12.9	6.4	5.6	5.8	5.7
Three-week-old larva	38.6	38.7	35.2	34.5	13.7	13.7	6.4	7.9	6.6	6.8
	38.6	38.4	34.3	33.7	13.3	13.8	6.6	6.7	7.0	6.6
	38.4	39.1	34.5	34.8	14.0	14.4	6.7	6.8	6.6	6.7
	38.5	38.7	34.3	33.9	13.4	14.0	6.6	6.9	6.5	6.6
	39.0	38.6	35.8	34.3	13.7	13.5	6.4	6.5	6.5	6.8
Adult	38.4	38.2	32.4	31.9	11.8	11.7	6.9	7.5	7.0	7.0
	38.6	38.2	33.5	34.0	11.2	11.4	7.0	7.3	7.2	7.1
	38.1	38.0	33.1	32.3	11.4	10.7	6.9	8.1	7.3	7.1
	38.8	38.2	34.6	33.0	12.2	11.4	6.8	7.3	7.0	7.0
	38.3	39.0	33.8	32.5	11.6	11.8	7.6	6.7	7.0	6.7

1/ Rotor with top plate removed
2/ Without aspiration

Table 5. Percent of wheat stock sifted through a No. 10W sieve.

Stage of Infestation	13" Blade R, Corr. L.		14" Peg R, Smooth L.		14" Peg R[1], Smooth L.		12" Peg R[2], Smooth L.		12" Peg R, Smooth L.	
Uninfested	23.2	24.4	7.3	7.2	3.0	3.2	1.5	1.7	1.4	1.4
	23.3	23.0	7.8	7.2	2.9	3.1	1.7	1.6	1.6	1.5
	23.3	23.2	8.3	7.5	2.9	3.0	1.7	1.8	1.4	1.4
	23.0	23.2	7.4	7.8	3.1	3.2	1.6	1.7	1.4	1.3
	22.4	21.9	7.2	7.7	3.0	2.9	2.0	1.6	1.3	1.5
Egg	23.7	24.0	8.5	8.2	3.2	3.2	1.8	1.9	1.5	1.4
	23.8	23.3	8.0	8.3	3.1	3.3	1.8	1.9	1.4	1.4
	23.3	23.1	8.0	8.1	3.2	3.3	1.6	2.1	1.4	1.4
	23.6	22.7	8.0	8.2	3.2	3.2	1.6	1.9	1.3	1.5
	23.8	22.6	8.5	8.1	3.2	3.3	1.9	1.8	1.3	1.3
One-week-old larva	23.1	23.4	10.2	9.3	3.7	3.7	1.1	1.1	0.8	0.9
	24.1	24.3	9.2	10.5	3.9	3.5	1.2	1.3	0.8	0.9
	24.0	23.4	9.5	9.5	3.5	3.8	1.3	1.4	0.8	0.9
	23.5	25.1	9.8	10.5	3.8	3.8	1.1	1.0	0.8	0.9
	24.1	23.3	9.7	9.7	3.5	4.0	1.3	1.1	0.9	1.0
Three-week-old larva	23.4	24.9	9.8	9.7	4.6	4.5	1.4	1.9	1.1	1.0
	23.4	24.3	9.2	9.9	4.5	4.5	1.3	1.3	0.9	1.0
	23.4	22.7	9.5	9.8	4.9	5.1	1.4	1.2	1.0	1.1
	24.8	23.9	9.1	10.4	4.5	4.5	1.3	1.5	1.0	1.1
	24.8	25.6	10.3	9.3	4.5	4.6	1.3	1.2	0.9	1.0
Adult	25.3	24.0	8.3	7.5	3.6	3.6	1.7	2.1	1.2	1.3
	26.3	23.6	8.4	8.2	3.6	3.4	1.7	1.8	1.2	1.3
	23.7	24.0	8.1	7.5	3.5	3.5	1.6	2.0	1.2	1.3
	23.5	23.3	8.3	7.4	3.8	3.6	1.5	1.9	1.2	1.2
	24.1	22.8	7.8	7.6	3.6	3.5	1.9	1.6	1.2	1.2

1/ Rotor with top plate removed
2/ Without aspiration

2, 3 and 4.

Table 6. Analysis of variance of wheat stock removed by a No. 8W sieve when different rotor and liner combinations were employed on different stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	4	28,446.74 3/
Stage of development	4	16.89 2/
Interaction - TxS	16	25.10 1/
Observations	225	0.71
Total	249	

1/ Highly significant
2/ Not significant
3/ Highly significant

The analysis of variance (Table 6) shows that there is not a consistent difference between stages of insect development in the amount of stock removed by a No. 8W sieve. However, there is a significant difference in the amount of stock removed by a No. 8W sieve due to the type of rotor and liner employed.

The 13-inch blade rotor with corrugated liner produced the greatest amount of breakage and in turn the least amount of stock to be removed by a No. 8W sieve. The average amount of stock removed by a No. 8W sieve was 38.1 per cent for all stages of insect development.

When the 14-inch peg rotor with smooth liner was employed, the average amount of stock removed by a No. 8W sieve was 57.4

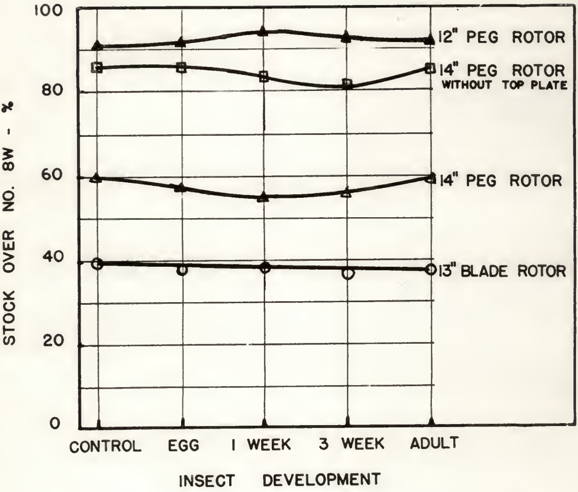


Fig. 2. Sifting analysis of stock removed by a No. 8W showing the effect of the impact action of different rotor and liner combinations on wheat containing different stages of infestation.

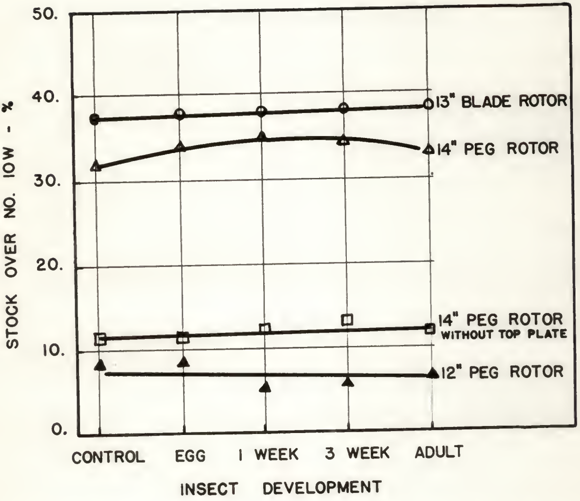


Fig. 3. Sifting analysis of stock removed by a No. 10W showing the effect of the impact action of different rotor and liner combinations on wheat containing different stages of infestation.

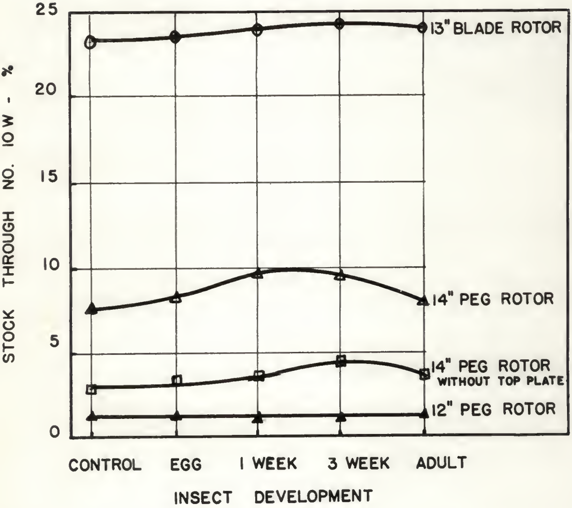


Fig. 4. Sifting analysis of stock through a No. 10W showing the effect of the impact action of different rotor and liner combinations on wheat containing different stages of infestation.

per cent for all stages of insect development. In using the 14-inch peg rotor without its top plate with a smooth liner, the average amount of stock removed by a No. 8W sieve was 84.3 per cent for all stages of insect development. An overall average of 91.6 per cent of the stock produced by a 12-inch peg rotor with a smooth liner was removed by a No. 8W sieve. When the same combination of a 12-inch peg rotor with a smooth liner was employed without aspiration, an average of 91.4 per cent of the stock was removed by a No. 8W sieve for all stages of insect development.

Table 7. Analysis of variance of wheat stock removed by a No. 10W sieve when different rotor and liner combinations were employed on different stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	4	11,432.89[3]
Stage of development	4	5.77[2]
Interaction - TxS	16	8.67[1]
Observations	225	0.23
Total	249	

1/ Highly significant
2/ Not significant
3/ Highly significant

The analysis of variance (Table 7) shows that there is not a consistent difference between stages of insect development in the amount of stock removed by a No. 10W sieve. However, there is a significant difference in the amount of stock removed by a No. 10W sieve due to the type of rotor and liner employed.

The following percentages of stock removed by a No. 10W sieve are the average amounts of stock produced by each rotor and liner combination on all stages of insect development. The wheat subjected to the Entoleter Scourer-Aspirator operation employing the 13-inch blade rotor with the corrugated liner had 38.2 per cent of its stock removed by a No. 10W sieve. The 14-inch peg rotor with the smooth liner produced stock which 33.7 per cent was removed by a No. 10W sieve. Only 12.1 per cent of the stock produced by the 14-inch peg rotor, without its top plate and with a smooth liner, was removed by a No. 10W sieve. When the 12-inch peg rotor with a smooth liner was employed, 7.0 per cent of its stock was removed by a No. 10W; while only 7.2 per cent of the stock was removed by a No. 10W sieve when the same rotor and liner combination without aspiration was employed.

The analysis of variance (Table 8) shows that there is not a consistent difference between stages of insect development in the amount of stock sifted through a No. 10W sieve. However, there is a significant difference in the amount of stock sifted through due to the type of rotor and liner combination employed.

The following amounts of stock were sifted through a No. 10W sieve when the different rotor and liner combinations were employed: the 13-inch blade rotor with a corrugated liner produced stock of which 23.7 per cent sifted through; the 14-inch peg rotor with a smooth liner produced stock of which 8.6 per

Table 8. Analysis of variance of wheat stock sifted through a No. 10W sieve when different rotor and liner combinations were employed on different stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	4	4,417.28 3/
Stage of development	4	4.61 2/
Interaction - TxS	16	3.38 1/
Observations	225	0.16
Total	249	

1/ Highly significant
2/ Not significant
3/ Highly significant

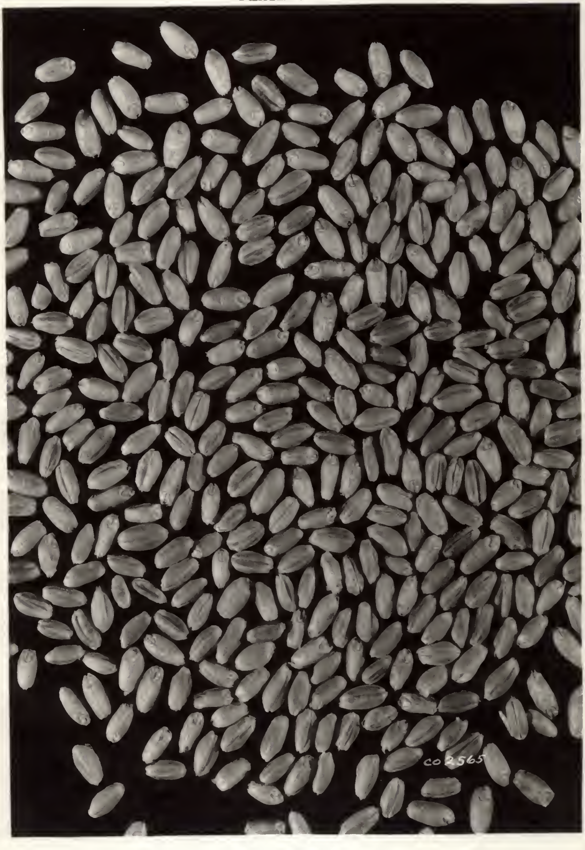
cent sifted through; the 14-inch peg rotor without its top plate with a smooth liner produced stock of which 3.6 per cent sifted through; the 12-inch peg rotor with a smooth liner produced stock of which 1.2 per cent sifted through; and the same 12-inch peg rotor with a smooth liner employed without aspiration sifted through 1.6 per cent of its stock through a No. 10W sieve.

Plate V provides a pictorial description of the wheat not subjected to the Entoleter Scourer-Aspirator operation. Plate VI shows wheat subjected to the impact action of the 13-inch blade rotor with a corrugated liner. Plate VII shows wheat subjected to the impact action of the 14-inch peg rotor with a smooth liner.

EXPLANATION OF PLATE V

Wheat not subjected to the Entoleter Scourer-Aspirator operation.

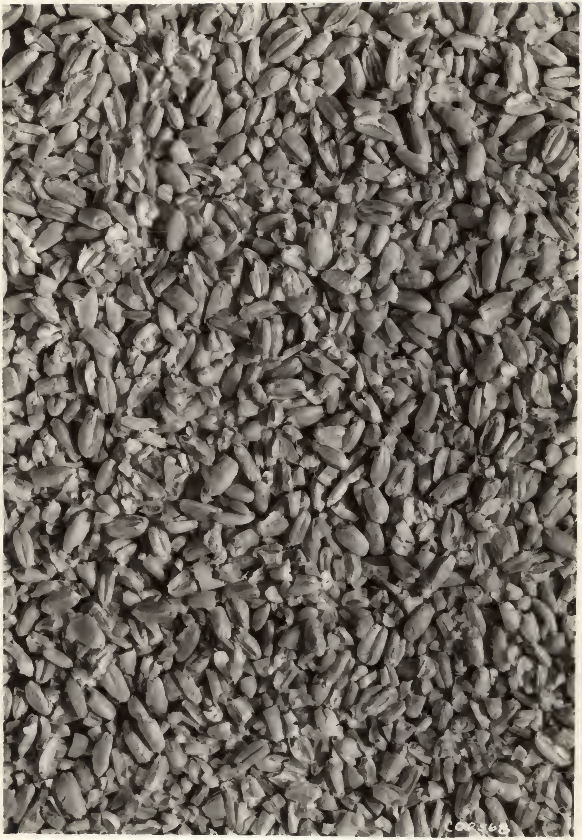
PLATE V



EXPLANATION OF PLATE VI

Wheat subjected to the impact action of the 13-inch blade rotor with a corrugated liner.

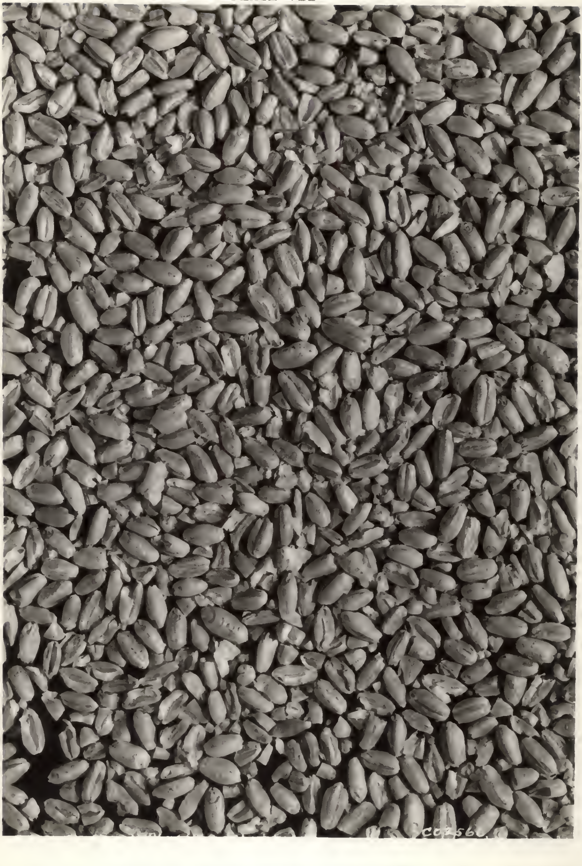
PLATE VI



EXPLANATION OF PLATE VII

Wheat subjected to the impact action of the 14-inch peg rotor with a smooth liner.

PLATE VII



Stain Test Results

The stain test was one of the three tests used in determining the effectiveness of the Entoleter Scourer-Aspirator operation in destroying and removing internal infestation. As stated previously, 10 samples of 100 kernels each were drawn at random from each 60-pound lot of wheat ran on each test. The results are shown in Table 10. The analysis of variance (Table 9) required the results to be pooled into two samples of 500 kernels each. This provided numbers of unbroken infested kernels per lot of 500 which were adequate for the variance analysis.

Table 9. Analysis of variance of number of infested kernels per 500 remaining after operation of different rotor and liner combinations employed on different stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	4	41.73 3/
Stage of development	3	43.76 2/
Interaction - TxS	12	35.09 1/
Observations	20	0.58
Total	39	

1/ Highly significant
2/ Not significant
3/ Not significant

The analysis of variance (Table 9) shows that there was a significant interaction between the stage of insect development

Table 10. Number of infested whole kernels per 100 remaining after the Entoleter Scourer-Aspirator operation.

Stage of Infestation	13" Blade R, Corr. L.		14" Peg R, Smooth L.		14" Peg R[1], Smooth L.		12" Peg R[2], Smooth L.		12" Peg R, Smooth L.	
Egg	2	2	1	1	3	1	0	2	1	0
	2	3	2	0	1	0	2	3	5	2
	3	2	1	0	0	1	6	2	2	1
	4	2	2	1	2	2	4	0	3	2
	1	3	2	2	1	1	5	2	0	2
One-week-old larva	1	3	1	2	1	0	3	1	0	0
	2	1	3	1	2	1	1	2	0	3
	2	3	3	1	0	1	0	0	3	0
	0	2	1	0	1	0	2	2	4	1
	0	3	2	2	0	1	1	1	2	2
Three-week-old larva	0	0	1	1	1	2	6	3	5	1
	1	1	0	1	2	1	4	4	2	2
	1	0	2	1	3	3	4	3	3	3
	2	0	0	0	0	3	4	3	4	3
	0	1	0	1	3	4	2	4	0	4
Adult	0	0	0	0	3	1	0	0	1	0
	2	1	0	0	1	3	0	1	1	2
	1	0	1	0	3	1	3	1	1	1
	0	0	1	1	2	3	1	1	2	0
	1	1	0	0	2	4	2	1	3	1

1/ Rotor with top plate removed
2/ Without aspiration

and the type of rotor and liner combination employed. However, neither the variation of the stage of insect development nor the type of rotor and liner combination were statistically significant by themselves. This means that neither the stage of insect development or the type of rotor and liner employed produced consistent differences.

To determine the source of the differences, a t-test technique was employed as shown in Table 11. This test showed that the greatest differences lie between the one-week-old and three-week-old larva stages of development. For all rotor and liner combinations employed, with the exception of the 14-inch peg rotor without its top plate, the adult stage had as few if not fewer unbroken infested kernels remaining after the Entoleter Scourer-Aspirator operation than the other stages.

Table 11. Average number of unbroken infested kernels per 500 after the Entoleter Scourer-Aspirator operation.

Stage of Infestation	13" B., Cor. L.		14" P., Sm. L.		14" P^1, Sm. L.		12" P^2, Sm. L.		12" P. Sm. L.
Egg	12	**	6		6	**	13.5	**	9
	**				**		**		
1-wk larva	8.5		8	**	3.5	**	6.5		7.5
	**		**		**		**		**
3-wk larva	3		3.5	**	11	**	18.5	**	13.5
							**		**
Adult	3		1.5	**	11.5	**	5		6

1/ Rotor with top plate removed
2/ Without aspiration
** Significance at 1% level; $t_{.01} = 2.17$

No definite trend is indicated. However, the 13-inch blade rotor with corrugated liner, and the 14-inch peg rotor with a smooth liner fractured more infested kernels in the three-week-old larva and adult stages than did the other combinations. Fig. 5 illustrates graphically the effectiveness of the different rotor and liner combinations to break infested kernels at different stages of insect development.

Maturity Test

Table 12 shows the average number of live insects per 50 grams after the Entoleter Scourer-Aspirator operation. The egg stage was the most difficult stage of insect development to kill.

Table 12. Average number of live insects per 50 grams after the Entoleter Scourer-Aspirator operation.

Stage of Infestation	13" Blade R, Corr. L.	14" Peg R, Smooth L.	14" Peg R[1], Smooth L.
Egg	0	0	18
	1	1	16
	0	0	17
	1	0	10
	1	0	13
One-week-old larva	0	0	13
	0	0	9
	1	0	10
	0	0	11
	0	0	4
Three-week-old larva	0	0	6
	0	0	6
	0	0	7
	0	0	6
	0	0	8
Adult	0	0	3
	0	0	8
	0	0	3
	0	0	6
	0	0	3

1/ Rotor with top plate removed

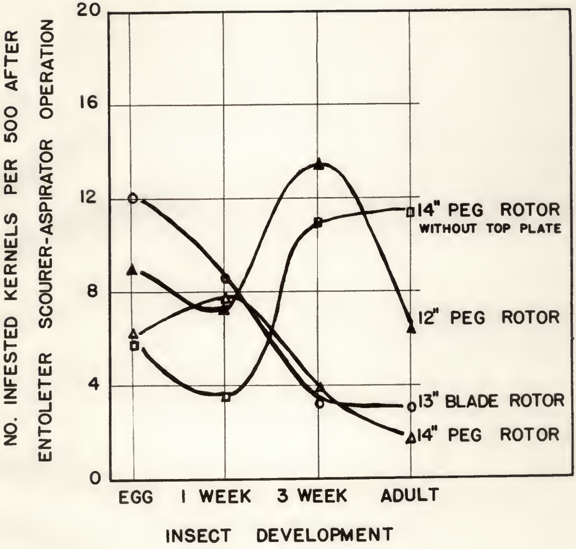


Fig. 5. Effectiveness of the different rotor and liner combinations to break infested kernels at different stages of insect development.

Only one live insect in 500 grams developed from the egg stage when the 14-inch peg rotor with a smooth liner was employed; however, no insects matured from the other stages of development when this rotor and liner were used. Three live insects per 500 grams were found in the egg stage; only one live insect in 500 grams developed in the one-week-old larva; and none were found in the three-week-old larva and adult stages of development when the 13-inch blade rotor with a corrugated liner was employed.

When the 14-inch blade rotor without its top plate with a smooth liner was used, an average of 14.8 live insects per 50 grams developed from the egg stage; 9.4 from the one-week-old larva stage; 6.6 from the three-week-old larva stage and 4.6 live insects per 50 grams developed from the adult stage after being subjected to the Entoleter Scourer-Aspirator operation. Thus the effectiveness of the top plate for the proper functioning of the Entoleter Scourer-Aspirator is demonstrated.

Tests were ran on wheat not subjected to the Entoleter Scourer-Aspirator operation to determine the number of live insects that developed from the infested wheat. These results are recorded in Table 13. An average of 94 insects per 50 grams matured from the wheat not subjected to the Entoleter Scourer-Aspirator operation. Thus the actual per cent of live infestation in the wheat was 4.7 per cent.

Table 13. Average number of live insects per 50 grams of wheat not subjected to the Entoleter Scourer-Aspirator operations.

Stage of Infestation	13" Blade R, Corr. L.	14" Peg R, Smooth L.	14" Peg R[1], Smooth L.
Egg	96	88	93
	105	92	90
	90	87	86
One-week-old larva	109	84	85
	110	96	93
	96	80	110
Three-week-old larva	99	101	82
	92	115	86
	90	103	84
Adult	98	85	108
	98	94	103
	90	81	82

1/ Rotor with top plate removed

Fragment Count Results

Fragment counts were determined on the wheat stock produced by the impact action of the 13-inch blade rotor with a corrugated liner, and by the impact action of the 14-inch peg rotor with a smooth liner. Control fragment counts were made on infested wheat not subjected to the Entoleter Scourer-Aspirator operation. The results are tabulated in Table 14.

No fragments were found in the uninfested wheat, whole or fractured. The reason no fragments were found in the egg stage of development is believed to be due to the digestion of the eggs in the fragment count technique. Insect fragments from the one-week-old larva stage were found in the wheat not subjected to the Entoleter Scourer-Aspirator operation. How-

Table 14. Fragment counts from 50-gram samples of ground wheat stock.

Stage of Infestation	Un-Entoleted Wheat		13" Blade R, Corr. L.		14" Peg R, Smooth L.	
Uninfested	0	0	0	0	0	0
	0	0	0	0	0	0
Egg	0	0	0	0	0	0
	0	0	0	0	0	0
One-week-old larva	3	6	0	0	0	0
	4	3	0	0	0	0
Three-week-old larva	14	12	4	3	9	11
	16	13	5	2	10	8
Adult	132	139	55	51	45	37
	140	135	57	50	52	47

ever, no fragments were found in this stage of development when the wheat was subjected to the impact and aspirating action of the machine. When the 13-inch blade rotor with corrugated liner was employed on the three-week-old larva stage of development, there was a reduction of 74.2 per cent of the fragment count in the wheat stock in comparison with wheat not subjected to the Entoleter Scourer-Aspirator operation. When the 14-inch peg rotor with smooth liner was employed there was a reduction of 30.9 per cent in fragment count in the three-week-old larva stage of development. The fragment count was reduced 66.9 per cent when the 14-inch peg rotor with a smooth liner was employed on the three-week-old larva stage of development in comparison with wheat not subjected to the operation. There was a reduction of 61.1 per cent of the fragment count when the 13-inch blade rotor with a corrugated liner was employed on the three-week-old larva stage of insect development.

Stock Removed by Aspiration

The amount of stock removed during the Entoleter Scourer-Aspirator operation by aspiration was divided into two portions. The more heavily aspirated stock settled in the expansion chamber while the lighter material was removed by the dust collector. Plate VIII gives a photographic description of the heaviest aspirated stock. Plate IX is a photograph of the lighter material.

The analysis of variance of the amount of stock removed by the expansion chamber is shown in Table 15. There are significant differences due to both the type of rotor and liner combination employed, and the stage of insect development. The greatest variation was produced by the rotor and liner combinations as illustrated in Fig. 6.

Table 15. Analysis of variance of stock removed by expansion chamber when different rotor and liner combinations were employed on different stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	3	9.862[2]
Stage of development	4	0.557[1]
Interaction - TxS	12	0.145
Total	19	

1/ Significant at 1% level
2/ Highly significant

EXPLANATION OF PLATE VIII

Photograph of the aspirated stock removed by the expansion chamber.

PLATE VIII

EXPLANATION OF PLATE IX

Photograph of aspirated stock removed by the dust collector.

PLATE IX

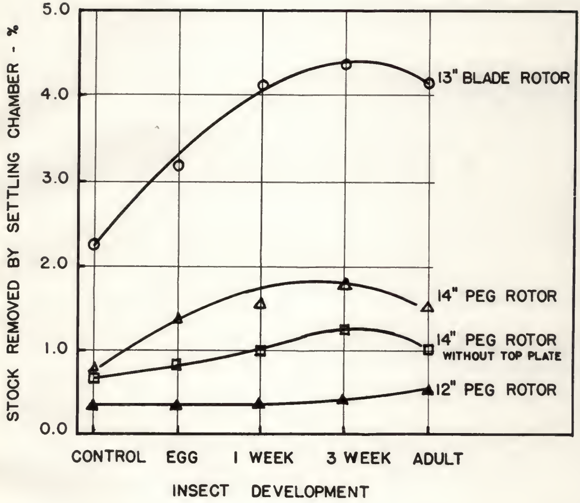


Fig. 6. Effect of the expansion chamber in collecting heavy aspirated stock from wheat containing different stages of infestation

Table 16 shows the percentages of stock removed in the expansion chamber when different rotor and liner combinations were employed on different stages of infestation. The greatest amount of material removed by aspiration occurred during the operation employing the 13-inch blade rotor with a corrugated liner. The impact action of rotors arranged in order of greatest amount of material removed by aspiration were as follows.

(1) 13-inch blade rotor with corrugated liner;

(2) 14-inch peg rotor with smooth liner;

(3) 14-inch peg rotor without top plate with smooth liner;

(4) 12-inch peg rotor with smooth liner.

Table 17 shows a similar analysis of variance for the stock removed by the dust collector as for the stock settled in the expansion chamber. The data gathered on the percentages of

Table 17. Analysis of variance of stock removed by dust collector employing different rotor and liner combinations on different stages of insect development.

Source of Variation	Degrees of Freedom	Variance
Type of combination	3	1.288[2]
Stage of development	4	0.134[1]
Interaction - TxS	12	0.031
Total	19	

1/ Significant at 1% level.
2/ Highly significant.

Table 16. Percentages of stock removed by expansion chamber.

Stage of Infestation	13" Blade R, Corr. L.	14" Peg R, Smooth L.	14" Peg R[1], Smooth L.	12" Peg R, Smooth L.
Uninfested	2.20	0.75	0.68	0.33
Egg	3.17	1.37	0.77	0.32
1-wk larva	4.02	1.56	0.93	0.35
3-wk larva	4.36	1.75	1.21	0.39
Adult	4.15	1.48	0.98	0.52

1/ Rotor with top plate removed

Table 18. Percentages of stock removed by dust collector.

Stage of Infestation	13" Blade R, Corr. L.	14" Peg R, Smooth L.	14" Peg R[1], Smooth L.	12" Peg R, Smooth L.
Uninfested	0.83	0.38	0.43	0.15
Egg	1.25	0.62	0.48	0.17
1-wk larva	1.62	1.09	0.61	0.19
3-wk larva	1.75	0.75	0.78	0.19
Adult	1.58	0.66	0.70	0.22

1/ Rotor with top plate removed

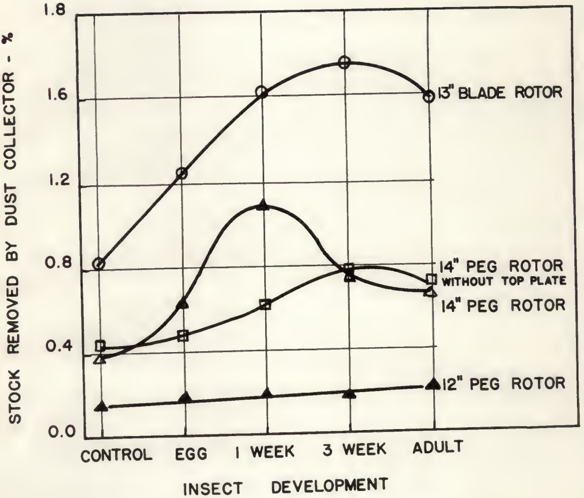


Fig. 7. Effect of dust collector in collecting light aspirated stock from wheat containing different stages of infestation.

stock removed by the dust collector are recorded in Table 18. These results are illustrated also in Fig. 7.

Air and Power Measurements

The static pressure measurements of the air pulled through the aspirating system remained constant throughout the experiment. The static pressure maintained was 1.8 inches of water column, seven inches from the exit of the aspirator.

The power consumption of the Entoleter Scourer-Aspirator system varied with the type of rotor and liner combination employed. The power consumptions of the 1.5 horsepower induction motor, operating under a feed load of 30 pounds per minute were as follows.

	With Load	Without Load
14-inch peg rotor with smooth liner	1.44 kw	0.58 kw
14-inch peg rotor without top plate with smooth liner	1.20 kw	0.46 kw
13-inch blade rotor with corrugated liner	1.18 kw	0.46 kw
12-inch peg rotor with smooth liner	1.04 kw	0.44 kw
12-inch peg rotor without aspiration	0.92 kw	0.38 kw

SUMMARY AND CONCLUSIONS

The experimental work has shown that several factors affect the effectiveness of the Entoleter Scourer-Aspirator system to destroy and remove "hidden" insect infestation in wheat. The type of rotor and liner combination employed will affect the amount of breakage of the wheat stock, the amount of material removed by aspiration, and the amount of insects and fragments exposed for removal by aspiration. Depending upon the rotor and liner used, the stage of insect development will affect the number of whole infested kernels remaining after the Entoleter Scourer-Aspirator operation. The stage of infestation will also affect the amount of material removed by aspiration. The stage of infestation will not greatly affect the amount of breakage.

The impact action of the 13-inch blade rotor with corrugated liner produced excessive breakage without greatly further reducing the amount of "hidden" infestation as compared to the 14-inch peg rotor with a smooth liner. The impact action of the 14-inch peg rotor with smooth liner produced less breakage and yet had fewer whole infested kernels remaining after the operation than did the 13-inch blade rotor with a corrugated liner.

The effectiveness of the Entoleter Scourer-Aspirator operation to break open and remove "hidden" infestation from wheat showed that the stock settled out in the expansion chamber contained many insect fragments. This stock was of an undesirable nature, and therefore no attempt was made to reclaim or classify the more heavily aspirated stock to be sent for further milling. Thus no fragment counts were made on the aspirated stock settled in the expansion chamber.

In view of the present work, the evidence obtained shows that none of the rotor and liner combinations would destroy and remove all of the infestation. Nevertheless, the use of the Entoleter Scourer-Aspirator is the most effective infestation control equipment now available. The 14-inch peg rotor with a smooth liner appeared to be the best rotor and liner combination.

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