THE EFFECTS OF FUMIGANTS AND PROTECTENTS IN WHEAT ON THE ZELENY SEDIMENTATION TESTS

by

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INTRODUCTION AND OBJECTIVES

In July, 1961, the United States Department of Agriculture established the Zeleny Sedimentation test as a method of establishing, in part, the quality of wheat. This test is relatively simple and provides a rapid estimate of the bread-baking quality of wheat. The test depends upon the swelling of the wheat gluten when soaked in water and lactic acid. The volume of swollen gluten that is measured in the test depends on both the quantity and the quality of gluten in the wheat.

The present work relates the use of various pesticides to protect stored wheat from damage by various agricultural pests to the effect on the sedimentation values of treated wheat.

LITERATURE REVIEW

The bread-baking quality of wheat has been drawing the attention of various research workers, as well as the Government, for a long time. In 1947, Zeleny suggested a simple sedimentation test for estimating bread-baking and gluten qualities of the wheat flour.

Pinckney et al. (1957) suggested some modifications in the sedimentation test devised by Zeleny in 1947. The modifications by Pinckney et al. made the test suggested by Zeleny applicable to 'soft' as well as 'hard' varieties of wheat. This test also provided greater uniformity in laboratory results.

However, in spite of the fact that the sedimentation test is being used extensively, there is a lack of literature which could throw light upon the variable factors which might affect the test.

A review of literature indicates that Shuey (1961) studied the effects of heat treatment on a single lot of wheat, including the effects of sprout damage, and insecticides, and reported that: a) excessive heat during drying lowered the sedimentation value, b) fumigation had no effect on sedimentation value, and c) sprout damage up to about 50 percent did not lower the sedimentation value.

Linko and Ruei-Chen (1962) investigated the effects of germination and reported that the sedimentation value decreased as the germination period increased. They also studied the effect of storage at 30° to 40° F on the sedimentation value of wheat and reported that the sedimentation test had its merit in evaluating the quality of wheat.

Sibbit and Gilles (1962) conducted a study on the sedimentation test as an index of hard red spring wheat quality and concluded that some effects of grinding and other sources of variation, such as subjection to successive wetting and drying and commercial drying and blending of wheat of dissimilar protein content, do affect the statistical accuracy of the test. Therefore, they suggested that a number of tests should be used to accurately define quality in wheat flour. Their data showed that the sedimentation test did not measure potential quality of sound, hard red spring wheat nearly as well as the protein test. Upon these findings, the authors suggested that, when used in conjunction with other recognized quality tests, this sedimentation test may provide useful supplemental information to assist in classifying wheat in broad quality ranges like 'Weak', 'Medium', and 'Strong'.

Durham and Warren (1962) conducted a study of ash content of whole wheat and Tag-Hour, particle size distribution and crude fiber. They found that these factors affected the sedimentation value. Durham and Warren also found that a factor associated with protein content affects the qualitative increase or decrease in sedimentation value after fumigation. The sedimentation value of the highest protein wheat measured the most, and the lowest protein wheat actually decreased in sedimentation value after fumigation.

Schlesinger (1963) worked on several lots of wheat under normal elevator storage conditions for about one year and reported that sedimentation values of these lots, which were homogenous at the outset, showed a gradual decline during the first five months.

MATERIAL AND METHODS

The work on the project was carried out with the equipment and reagents described in the Government Instruction 918-11, Rev. 1, issued May 1, 1962, by the United States Department of Agriculture.

Kinds of Grain Used

Wheat Triticum aestivum L., Ottawa Variety, Hard Red Winter, (Class III).

Wheat Triticum aestivum L., Pawnee Variety, Hard Red Winter, (Class IV).

Mixed wheat, unclassified.

Fumigants

The fumigants used were those which are widely used to protect the grain from insect damage:

1. Vertifume

Active Ingredients:	Carbon tetrachloride	82.5%
	Carbon bisulfide	16.5%
Inert Ingredients:		1.0%
		100.0%

Recommended dosage, 3 gallons per 1,000 bushels of wheat.
Recommended exposure time, 72 hours.

2. Dowfume-75

Active Ingredients:	Ethylene dichloride	70.2%
	Carbon tetrachloride	29.8%
		100.0%

Recommended dosage, 3 gallons per 1,000 bushels of wheat.
Recommended exposure time, 72 hours.

3. Dowfume EB-5

Active Ingredients:	Carbon tetrachloride	63.6%
	Ethylene dichloride	29.2%
	Ethylene dibromide	7.2%
		100.0%

Recommended dosage, 3 gallons per 1,000 bushels of wheat.
Recommended exposure time, 72 hours.

4. Serafume

Active Ingredients:	Ethylene dibromide	3.5%
	Carbon bisulfide	10.0%
	Ethylene dichloride	10.0%
	Carbon tetrachloride	76.5%
		100.0%

Recommended dosage, 3 gallons per 1,000 bushels of wheat.
Recommended exposure time, 72 hours.

5. Chloropicrin or Larvicide

Active Ingredients:	Chloropicrin	99.0%
Inert Ingredients:		1.0%
		100.0%

Recommended dosage, 2½ lbs. per 1,000 bushels of wheat.
Recommended exposure time, 72 hours.

6. Profume or Methylbromide

Active Ingredients:	Methyl bromide	98.0%
	Chloropicrin	2.0%
		100.0%

Recommended dosage, 1 pound per 1,000 cu. ft.
Recommended exposure time, 24 hours.

Protectents

1. Malathion Grain Protectent

Active Ingredient:	57%
Arromatic Petroleum Solvent:	37%
Inert Ingredient:	6%
	100%

O'O-dimenthyl dithiophosphate of diethylmereaptosuccinate.
Recommended dosage, 1 pint per 1,000 bushels of wheat.

2. Pyrenone E.C. 60-6

Active Ingredients:	Technical propernyl butoxide	60%
	Pyrethrins	6%
Inert Ingredients:		34%
		100%

Recommended dosage, 1 quart per 1,000 bushels of wheat.

3. Vapona Insecticide E.C.

Contained 2 pounds per gallon by weight

Active Ingredients:	2.2-dichlorovinyldimethyl phosphate	21.8%
	Related compound	1.6%
	Petroleum hydrocarbons	65.6%
Inert Ingredients:		11.0%
		100.0%

Dosage used, 4 and 8 parts per million.

4. Diazinon AG 250

25% Emulsifiable Concentration

Active Ingredients:	0,0-diethyl-0- (2-isopropyl-4-methyl-6-pyrimidinyl) Phosphoroltricate	25%
	Xylene	70%
Inert Ingredients:		5%
		100%

Dosage used, .8 parts per million.

METHOD OF APPLICATION AND EXPOSURE

Five fumigants, Vertifume, Doufume-75, Dowfume EB-5, Serafume and Chloropicrin were applied directly onto the wheat samples. Fumigants were injected by micro-syringe into two different size jars: one-quart jars containing 500 grams of wheat and one-gallon jars containing 3,000 grams of wheat. A control sample was run simultaneously with the treated ones. Samples were kept under two different temperatures, 100° F and room temperature 80° F ($\pm$5° F).

A special kind of opener, as described by Boty (1961), with leur-lok hypodermic syringe of 50 cc capacity with standard leur-lok 3-way syringe valve, was used for the application of Methyl bromide.

All samples were fumigated with the recommended dosages and were exposed for the recommended exposure time as mentioned previously. Due to the negative results obtained by the above treatments and exposure times, these dosages were doubled and the exposure times were increased.

Four samples of wheat, each weighing 3,000 grams, were treated with protectents with a special painter's air brush sprayer pictured in Plate I. The sprayer discharged into a rotating drum which turned at 12 rpm, having four fins, each one inch wide and about the same length of the drum. The drum and fins are shown in Plate II. The wheat was treated with malathion, pyrenone, diazinon and vapona at 30 pounds pressure per square inch. Distilled water was used as diluent for the chemicals mentioned above. To check the difference in moisture content, the control for each treatment was sprayed with the same amount of diluent (distilled water).

Samples treated with malathion and pyrenone were kept in one-gallon jars to determine the effects of storage at temperatures of 100° F and 80° F ($\pm$5). In the case of Vapona and Diazinon the test samples were kept only at 80° F ($\pm$5). The time of storage after treatment is given in each table for that particular treatment.

The fundamental procedure of the sedimentation test as described by Zeleny (1947), and further modified by Pinckney et al. (1957), was followed.

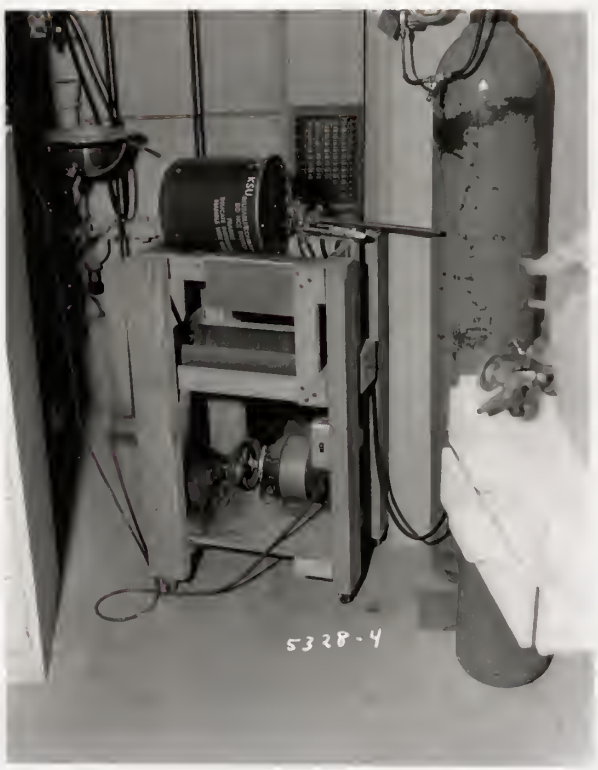
RESULT AND DISCUSSION

A standardization test for the sedimentation value of Ottawa and Pawnee wheat was obtained as 60 and 40, respectively. The moisture content was obtained by the air-oven method for moisture analysis and in some cases, verified by the Steinite electronic moisture tester. At the time of standardization, the moisture

EXPLANATION OF PLATE I

Type of sprayer and its location with the other parts of sprayer, CO_2 tank, drum and machine which rotates the drum while spraying or operating.

PLATE I



EXPLANATION OF PLATE II

Inside view of the mixing or spraying drum showing location of the fins.

PLATE II

content of the Ottawa and Pawnee wheat was found to be 11.5% and 10.8% respectively.

To determine the corrected sedimentation value (14% moisture basis), the same conversion factors were followed as described in Government Instruction 918-11, Rev. 1, 1962, by the United States Department of Agriculture.

For correlation of inter-laboratory test results, a similar test on the samples of the same wheat was performed by the Department of Flour, Feed and Milling Industries, Kansas State University, and the United States Department of Agriculture, ASCS Laboratory, Manhattan, Kansas.

The effects of Serafume, Dowfume EB-5, Dowfume-75, Vertifume, and Chloropicrin on the sedimentation value of Pawnee and Ottawa wheat are shown in Tables 1 and 2.

Table 1. Effect of fumigants on the sedimentation value of Pawnee wheat sedimentation values.

	Recommended dosage at 80° F (±5)		Double dosage at 100° F		
	Exposure time in days		Exposure time in days		
Treatments	3	6	6	14	20
Serafume	29	28	35	36	34
Dowfume EB-5	29	28	35	32	34
Dowfume-75	29	28	34	34	34
Vertifume	29	28	35	37	35
Chloropicrin	30	30	34	31	33
Control	29	28	34	34	33

No significant effect was found when either the recommended dosage or the recommended exposure time at room temperature was

varied, as shown in Table 1. Thus the dosages were doubled and the fumigated wheat samples were stored at 100° F to evaluate the effect of temperature on fumigated wheat.

A considerable effect of storage on the sedimentation value of wheat was described by Anderson (1963). However, Linko and Ruei-Chen (1962) stated that other factors such as moisture and temperature will also affect the sedimentation value.

Table 2. Effect of fumigants on the sedimentation value of Ottawa wheat.

	Double dosage at room temp. 80° F (±5)	Double dosage at 100° F
	Exposure time in days	Exposure time in days
Treatments	3	3
Serafume	43	43
Dowfume EB-5	44	45
Dowfume-75	43	42
Vertifume	43	45
Chloropicrin	43	44
Control	44	43

Since no effect on the sedimentation value of wheat was found when it was fumigated using the recommended dosage and exposure time, the effects of double dosage treatments at two different temperatures were determined (Table 2).

No appreciable decrease or increase in the sedimentation value of the fumigated sample was noticed. Durham and Warren (1962) stated that a factor associated with protein content affects the quantitative increase or decrease in sedimentation values after fumigation. High protein wheat increased in

sedimentation value, while the sedimentation value of low protein wheat decreased after fumigation. The fumigants used by the research workers mentioned above were not the same but were quite similar as used in this study.

Durham and Warren (1962) found that methyl bromide has the least effect on the sedimentation value of wheat.

Table 3. Effect of methyl bromide on the sedimentation value of Pawnee and Ottawa wheat.

	Stored at room temp. 80° F (±5)		Stored at 100° F	
	Storage time in days		Storage time in days	
Pawnee wheat treatments	11	28		28
Recommended dosage	38	37		37
Double dosage	37	37		36
Control	38	37		38
	Storage time in days		Storage time in days	
Ottawa wheat treatments	5	28	5	28
Recommended dosage	42	41	42	42
Double dosage	42	40	42	42
Control	42	41	42	42

Apparently no positive results were obtained in the study of the effects of six different fumigants given in Tables 1, 2 and 3 on the sedimentation value of Pawnee and Ottawa wheat.

In recent years the increasing use of protectents on stored grain aroused concern about their effects on the sedimentation value. A short study was conducted on the effect of malathion, Pyrenone, Vapona and Diazinon. The results are shown in Table 4.

Table 4. Effect of protectents on the sedimentation value of wheat.

Treatments	Wheat variety	Exposure time in days	Storage Temp. in F	Sedimentation Value
Malathion[1]	Pawnee	6	80° F (±5)	24
Control	"	"	"	24
Malathion	"	"	100° F	24
Control	"	"	"	24
Malathion	Ottawa	6	80° F (±5)	39
Control	"	"	"	40
Malathion	"	"	100° F	39
Control	"	"	"	40
Pyrenone	Pawnee	14	80° F (±5)	35
Control	"	"	"	35
Pyrenone	"	30	"	34
Control	"	"	"	34
Pyrenone	"	14	100° F	34
Control	"	"	"	34
Pyrenone	"	30	"	32
Control	"	"	"	33
Pyrenone	Ottawa	14	80° F (±5)	42
Control	"	"	"	42
Pyrenone	"	30	"	41
Control	"	"	"	41
Pyrenone	"	14	100° F	41
Control	"	"	"	41
Pyrenone	"	30	"	39
Control	"	"	"	39
Vapona 4 ppm	Mixed wheat	4	80° F (±5)	33
Vapona 8 ppm	"	"	"	32
Control	"	"	"	33
Vapona 4 ppm	"	8	"	33
Vapona 8 ppm	"	"	"	33
Control	"	"	"	33
Diazinon 8 ppm	"	4	"	27
Control	"	"	"	28

[1]Unless stated otherwise, rate treated was commercially recommended.

No significant effect was found in either variety of wheat treated with malathion. So far, there is not much evidence on the effect of protectents on the sedimentation value of wheat.

Negative results were obtained when pyrenone 60-6 was used on Ottawa and Pawnee wheat and when mixed Hard Red Winter Wheat was treated with Vapona and Diazinon.

SUMMARY AND CONCLUSIONS

Storage and temperature do affect the sedimentation value, but no effect on sedimentation was found on Pawnee, Ottawa and mixed hard red winter wheat when treated with several fumigants and protectents at 80° F (±5) and 100° F.

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The purpose of this study was to find out the effect of fumigants and protectents in wheat, upon the Zeleny sedimentation test. Tests were conducted at room temperature 80° F (±5) and 100° F. Ottawa, Pawnee and mixed hard red winter wheat were used. The six fumigants and four protectents used were those widely in use, or being investigated for use, to protect stored wheat against insect attack. No effect of these pesticides, at twice recommended dosage and at a prolonged period of exposure, was observed on the Zeleny sedimentation tests.