ALTERNATE STORAGE METHOD FOR WHOLE COTTONSEED

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Abstract

A study was conducted to determine the feasibility of storing cottonseed in silage bags at the University of Georgia Coastal Plain Experiment Station in Tifton, Georgia. The study contained six different treatments. The treatments were hot gin run seed with and without preservative, cool seed with and without preservative, and wet seed with and without preservative. Each treatment contained approximately 10 tons of cottonseed. The study was initiated on December 12, 1995 and ended on August 26, 1996. Samples for quality, moisture, mycotoxins, and insect populations were taken at the filling of the bags, on April 12, 1996, and at the emptying of the bags. A cottonseed sample was placed in a conventional seed warehouse to compare insect populations. Three thermocouples were placed in each bag. One was placed near the top, one on the east near the bottom, and one on the west side near the bottom. The moisture content of the low level moisture bags ranged between 7.0 and 8.5 percent wb. The high moisture level bags ranged between 10.9 and 13.5 percent wb. The cottonseed in conventional storage contained more insects than the cottonseed stored in the bags. The percent fatty acid content in the low moisture cottonseed increased an average of 2.5 percentage points. The percent fatty acid content in the two high moisture cottonseed bags increased from 7.0 percent to 18.5 percent and from 14.5 percent to 23.0 percent. The quality of the cottonseed deteriorated more in the high moisture cottonseed than the low moisture cottonseed. The cottonseed was tested for mycotoxins during the test. Aflatoxin and zearalenone was not detected in any of the samples. Vomitoxin was found in the initial samples at low levels ranging from 0.5 to 1.2 ppm; however, its level decreased during storage. The temperatures in the high moisture bags remained higher during most of the tests.

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Introduction

Cotton production in Georgia has increased rapidly from 427,000 acres in 1991 to 1,520,00 acres in 1995. This growth in production increased the need for cottonseed storage.

A preliminary study was conducted at the Chickasha Oil Company in Albany, Georgia in 1995 to determine the feasibility of placing cottonseed into silage bags for temporary storage. Two different versions of bagging machines were used. The PRO GRAIN BAGGER, manufactured by AG-BAG International LTD, constructs a 10 foot diameter bag, and was designed mainly for grain storage. This machine was equipped with a 24 inch wide conveyor belt which supplied a 16 inch auger that filled the bag and required auxiliary power supplied by a tractor. The AG-BAGGER model M-9000, also manufactured by AG-BAG International LTD, constructed a 12 foot diameter bag and was designed primarily for silage storage. It used a wide flat belt to feed a bag loading mechanism and required no external power unit.

On June 5 and 6, 1995, one bag was constructed using the PRO GRAIN BAGGER and two more were constructed using the AG-BAGGER. Each of the three bags were filled with one trailer truck load of cottonseed for a different warehouse. One warehouse was determined to have good quality cottonseed and the other two warehouses contained cottonseed of poorer quality.

Four gallons of DMX-7 Mold Inhibitor, manufactured by Delst Inc., was sprayed on the one truck load of the lower quality cottonseed as the bag was loaded. Initial samples indicated populations of 7, 3, and 101 adult red flour beetles, and 5, 8, and 4 red flour beetle larvae per gallon of cottonseed, respectively. However, no insects were found in samples removed from the bags on July 26, 1995. These results indicated the environment inside the storage bag may not be conducive to the development of the red flour beetle, which is commonly found in stored cottonseed in Georgia. Based on this preliminary study, it was determined that this method of storage warranted further study.

Materials and Methods

A study was conducted starting on December 12, 1995, at the University of Georgia Coastal Plain Experiment Station in Tifton, Georgia. Since the PRO GRAIN BAGGER seemed the most feasible, it was used exclusively in this study. The study evaluated six different treatments. Treatments were hot gin run seed with and without preservative, cool seed with and without preservative, and wet seed with and without preservative. To prepare these treatments, three trailer truck loads of seed initiating from different locations were used. The content of each truck was split into two separate bags for a total of six bags. The cottonseed was initially placed into a cottonseed storage

shed. It then was loaded into a silage wagon using a front-end loader and transported into the bagging machine. Approximately 10 tons of cottonseed were placed into each bag. A Teejet 8003 even flat fan nozzle was attached to the feeding conveyer of the bagging machine to apply the preservative. The preservative was applied at 28 psi at a rate of approximately 3 pounds per ton of cottonseed to the second bag of each truck load. The preservative applied was TenderKeep buffered propionic acid. Three thermocouples were placed in each bag. One was placed near the top, one was placed on the east side near the bottom and one was placed on the west side near the bottom. Temperature data was recorded each day for the first 15 days and then three times a week. Initial quality, moisture, mycotoxin and insect samples were taken from each bag as they were filled. Intermediate samples were taken on April 12, 1996. Final samples were taken when the bags were emptied on August 26, 1996. After the insect samples were analyzed, they were placed into the top of cottonseed stored at a seed warehouse. This was to give an insect comparison to the cottonseed stored in bags to the warehouse. The treatments, cottonseed type, initial temperature, and store weight is shown in Table 1.

Table 1. Bag Treatments, Cottonseed Temperature, and Weight.

Bag #	Seed Type	Preservative	Temperature (F)	Weight (Tons)
Bag 1	Hot Gin	No	92	10.3
Bag 2	Hot Gin	Yes	85	10.8
Bag 3	Cool	No	82	11.1
Bag 4	Cool	Yes	82	10.0
Bag 5	Wet	No	78	9.9
Bag 6	Wet	Yes	75	10.7

Discussion

The number and types of insects found at each sampling time is shown in Table 2. No insects were found in the cottonseed as the bags were loaded on December 12, 1995; however, the insect samples taken on April 12, 1996, contained some insects. Three different types of insects were found: red flour beetles, flat grain beetles, and warehouse pirate beetles. Red flour beetles are the most commonly reported pests in cottonseed stored in Georgia. Bag 2 and the cottonseed located in the conventional storage were the only places red flour beetles were located. Thirteen red flour beetles were found in the conventional storage as opposed to two being found in Bag 2. The conventional storage, Bags 1, 2, and 3, contained more insects than Bags 4, 5, and 6. The insects found in the bags had to enter through small openings in the bags. All final insect samples contained fewer insects than the April 12 samples. This is probably due to insect cycles or changing environmental conditions in the bags. Even though insects did find their way into the bags, the bags contained less insects than the conventional storage.

Temperature readings of the thermocouples located near the top of the bags were more sensitive to ambient temperature conditions and varied more. The temperatures of the thermocouples located on each side near the bottom of the bags were more stable. The temperature readings in Bags 1, 2, 3, and 4 were not very different from each other. The temperature readings in Bags 5 and 6 tended to be higher than those of the other bags. The temperature difference between the combined average temperatures of Bags 5 and 6 compared to the combined average temperature of Bags 1 and 2 and the combined average temperature of Bags 3 and 4 is shown in Figure 1. The higher moisture cottonseed remained at a higher temperature during storage. They, also, had more odor than the other bags.

Cottonseed grades for each sampling time are shown in Tables 3, 4, and 5. The initial moisture content was taken using a Koster tester, which is not as accurate as the oven dried method used in the next two samplings. The actual moisture content of the cottonseed ranged from 7 to 13.5 percent wb. Bags 5 and 6 contained high moisture cottonseed. The percent free fatty acid content in the low moisture cottonseed, bags 1, 2, 3, and 4, increased an average of 2.5 percent. The percent free fatty acid content in the high moisture cottonseed, bags 5 and 6, increased from 7 percent to 18.5 percent and 14.5 percent to 23.0 percent, respectively. This indicates that the quality of cottonseed deteriorated more in the high moisture cottonseed than in the low moisture cottonseed, which was expected.

It should be noted that the truckload of cottonseed used to fill bags 5 and 6 was rather poor quality seed (Table 5). Although the seed quality deteriorated further during this study, this deterioration was less than would be expected had the seed been stored under aerobic conditions.

Mycotoxin accumulation in stored grains and oilseeds depends primarily on moisture control. Since cottonseed is normally aerated to prevent moisture accumulation, the development of mycotoxins in the cottonseed stored in the silage bags was a concern. One method of controlling mold growth is the use of a mold inhibiter. Bags 2, 4, and 6 were treated with TenderKeep buffered propionic acid to determine if it was beneficial. The cottonseed was examined for three different mycotoxins as shown in Tables 3, 4, and 5. They were aflatoxin, vomitoxin, and zearalenone. Aflatoxin and zearalenone was not detected in any of the cottonseed samples during the study. Vomitoxin was found in the initial samples at low levels ranging from 0.5 to 1.2 ppm in the bags; however, its level decreased during storage.

Table 2. Insect Counts and Types During Tests.

	April 12, 1996			August 26, 1996		
	RFB*	FGB*	WPB*	RFB*	FGB*	WPB*
Bag 1	0.0	22.2	5.3	0.6	0.2	0.0
Bag 2	1.8	16.9	16.0	2.7	0.9	0.0
Bag 3	0.0	16.0	1.8	0.0	0.0	0.0
Bag 4	0.0	0.0	0.0	2.1	0.0	0.0
Bag 5	0.0	2.1	0.0	0.0	0.2	0.0
Bag 6	0.0	0.0	0.0	0.0	0.0	0.0
Bin	13.2	26.9	10.1	1.8	0.2	0.0

RFB = Red Flour Beetles
FGB = Flat Grain Beetles
WPB = Warehouse Pirate Beetles (Predator)
*Insects Per Pound

Table 3. Whole Cottonseed Grade and Mycotoxin Analysis

	Bag					
Item	1a	1b	1c	2a	2b	2c
% Foreign Matter	0.8	0.1	0.8	0.4	0.1	0.6
% Moisture (wb)	12.5*	7.0	7.5	12.5*	7.7	8.0
% Free Fatty Acids	5.5	5.0	6.0	9.0	8.5	13.0
% Oil	18.6	18.2	17.9	18.8	18.3	17.9
% Ammonia	4.40	4.23	4.30	4.38	4.26	4.28
Net Quality Index	85.2	87.2	83.2	71.2	73.2	55.2
Quality Index	105.8	103.2	102.4	106.5	103.7	102.2
Grade	90.0	90.0	85.0	76.0	76.0	56.5
Aflatoxin (ppb)	0.0	0.0	0.0	0.0	0.0	0.0
Vomitoxin (ppm)	0.8	0.0	0.0	0.5	0.0	0.0
Zearalenone (ppm)	0.0	0.0	0.0	0.0	0.0	0.0

a=filling of bags December 1995
b=intermediate samples April 1996
c=opening of bags August 1996
1=hot gin run
2=hot gin run+propionic
*Koster test field type

Table 4. Whole Cottonseed Grade and Mycotoxin Analysis

	Bag					
Item	3a	3b	3c	4a	4b	4c
% Foreign Matter	0.0	0.0	0.0	0.0	0.1	0.0
% Moisture (wb)	12.1*	8.4	8.1	12.1*	8.4	8.5
% Free Fatty Acids	10.0	9.0	13.0	10.0	9.0	12.5
% Oil	18.8	18.4	17.8	18.8	18.1	18.0
% Ammonia	4.27	4.10	4.17	4.22	4.09	4.07
Net Quality Index	67.2	71.2	55.2	67.2	71.2	57.2
Quality Index	105.8	103.2	101.2	105.5	101.4	101.4
Grade	71.0	73.5	56.0	71.0	72.5	58.0
Aflatoxin (ppb)	0.0	0.0	0.0	0.0	0.0	0.0
Vomitoxin (ppm)	0.5	0.3	0.0	1.0	0.0	0.0
Zearalenone (ppm)	0.0	0.0	0.0	0.0	0.0	0.0

a=filling of bags December 1995
b=intermediate sample April 1996
c=opening of bags August 1996
3=cool
4=cool+propionic
*Koster test field type

Table 5. Whole Cottonseed Grade and Mycotoxin Analysis

	Bag					
Item	5a	5b	5c	6a	6b	6c
% Foreign Matter	0.1	0.0	0.0	0.2	0.0	0.0
% Moisture (wb)	13.2*	10.9	11.5	13.2*	11.8	13.5
% Free Fatty Acids	7.0	7.5	18.5	14.5	17.5	23.0
% Oil	17.6	17.1	17.0	18.1	16.9	16.9
% Ammonia	3.89	3.74	4.10	4.13	3.94	4.07
Net Quality Index	79.2	76.4	33.2	49.2	36.2	12.7
Quality Index	98.7	95.8	97.6	102.2	96.2	97.0
Grade	78.0	73.0	below	50.5	below	below
Aflatoxin (ppb)	0.0	0.0	0.0	0.0	0.0	0.0
Vomitoxin (ppm)	1.2	0.2	0.3	1.0	0.0	0.0
Zearalenone (ppm)	0.0	0.0	0.0	0.0	0.0	0.0

a=filling of bags December 1995
b=intermediate smaple April 1996
c=opening of bags August 1996
5=wet
6=wet+propionic
*Koster test field type

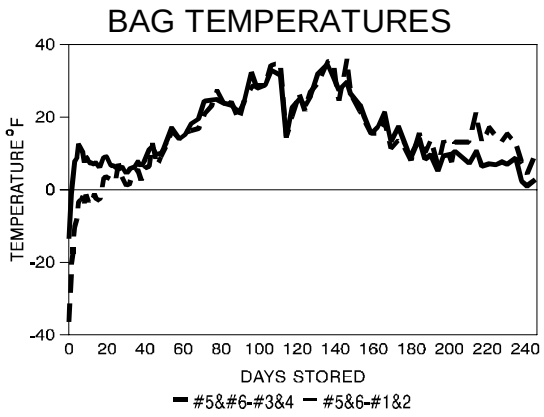

Figure 1. Average Temperatures of Bags 5&6 Compared to Average Temperatures of Bags 1&2 and Bags 3&4