EFFECTS OF PACKAGING MATERIALS, STORAGE CONDITION AND SEED MOISTURE CONTENT ON SEED QUALITY

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Preserving viability and vigor of seeds in storage presents a problem in many areas for many seedsmen. Dehumidified, low temperature storage will provide ideal, or near ideal, conditions. However, these conditions are not always avaliable and are not always feasible.

In many instances uncontrolled storage conditions can be improved by manipulation of the microenvironment. Selection of the proper packaging material and adjusting seed moisture contents will allow packaging of seeds in moisture resistant containers. This can prolong viability for various lengths of time depending on the storage conditions.

There is an interrelationship between packaging material, seed moisture and storage condition. How long seed remain viable in storage depends on the moisture content, the storage condition and the type of material in which the seed are packaged.

Corn, wheat, and soybeans were stored under the following conditions:

A. 85°F.-85% relative humidity
B. Open warehouse conditions (at Windfall, Indiana)
C. 0°F.-no humidity control

Packaging materials in storage were:

A. At 85°F. - 85% relative humidity
    1. Cloth
    2. Multiwall paper
    3. 7-mil polyethylene
        a. Umpunctured
        b. Punctured
        c. Maze opening

All polyethylene bags were heat sealed. Punctured bags contained several (4 to 6) small pin-hole size punctures. Maze opening is a design to allow air to escape after sealing and is illustrated in Figure 1.

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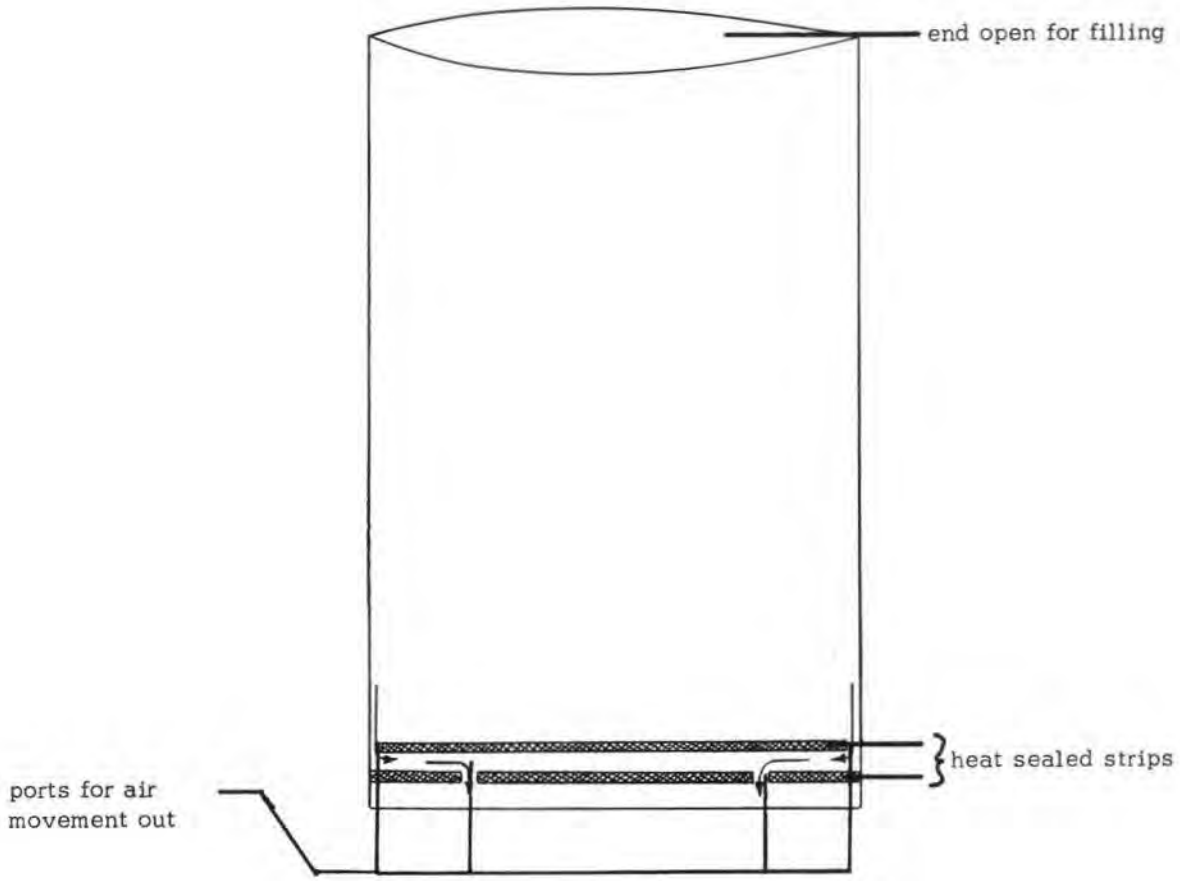

Figure 1. Diagram of "Maze" opening to allow air movement out of the filled, sealed bag and restrict air movement back into the bag.

B. In open warehouse storage packaging materials were:
   1. Multiwall paper
   2. 7 mil polyethylene
      a. Punctured
      b. Unpunctured

C. In frozen storage (0°F.) packaging materials were:
   1. 7 mil polyethylene - unpunctured

Moisture contents were:

A. At 85°F.-85% relative humidity
   1. Corn - 9.2% and 11.2%
   2. Soybeans - 9.0% and 11.2%
   3. Wheat 12.0%

B. In open warehouse storage
   1. Corn - 8.5% and 11.2%
   2. Soybeans - 9.0, 9.4 and 11.2
   3. Wheat - 12.6 and 10.7

Beans at 9.4% moisture were treated with a mecurial fungicide.

Wheat at 10.7% moisture was hot water treated.

C. In frozen storage
   1. Corn - 8.5%
   2. Soybeans - 9.0%
   3. Wheat - 12.6%

When seed were stored at 85°F.-85% relative humidity, polyethylene bags were far superior to multiwall paper and cloth bags. Seed of all three crops stored in multiwall paper and cloth bags were greatly reduced in germination after 2 months storage and were dead, or nearly so, after 4 months storage. Moisture content of corn at 2 months had increased to 16.7 to 18.4% moisture; soybeans had increased to 18.0-23.7% moisture and wheat to 27.7% moisture. The increase in moisture at this high temperature clearly explains the rapid drop in germination.

Seed packaged in polyethylene responded differently depending on the kind, percent moisture and type of package.

Corn packaged at 8.5% moisture maintained a higher percent germination and a higher relative percent cold test emergence than did corn packaged at 11.2% moisture. This again can be attributed to differences in moisture content. Corn packaged at 11.2% moisture had increased to approximately 12.0 to 12.5% moisture after 11

months storage, while corn packaged at 8.5% moisture did not reach a comparable moisture content until after 16 to 18 months storage. Corn packaged at 8.5% moisture did not decrease in germination until the 16-month testing period, while corn packaged at 11.2% moisture decreased in germination at the 8-month testing period.

Within moistue contents there was a difference in polyethylene bags. Punctured bags were inferior to unpunctured and maze opening type bags. Seed moisture content increased slightly faster in punctured bags than in other types. With corn packaged at the 11.2% moisture content, the maze opening type bag appeared to be slightly superior to the other polyethylene bags. Germination of corn seed in the maze opening type bag was 75% while seed in unpunctured bags germinated 48% after 12 months storage.

There was a steady decline in cold test emergence at both moisture contents and in all polyethylene bag types during the storage periods. Seed in punctured polyethylene bags declined faster than the other 2 bag types. Corn packaged at 11.2% moisture dropped below 50% of the original cold test emergence approximately 4 months earlier than did corn packaged at 8.5% moisture. Soybeans followed the same general trends as corn, although the decline in germination was much earlier than in corn. Beans packaged at 9.0% moisture maintained germination for 6 months while beans packaged at 11.2% moisture had declined slightly in germination after 2 months storage. Again punctured polyethylene bags were inferior to other types. This was more pronounced in beans packaged at 9.0% moisture. Apparently, 11.2% moisture is too high for soybeans packaged in moisture resistant containers. As with corn, cold test emergence declined as time in storage increased.

Wheat maintained good germination for 6 to 8 months in all polyethylene bags, but was severely reduced in germination after 11 months storage. Germination percentages after 8 months were 82, 83 and 92 for punctured, unpunctured and maze opening bags, respectively. As with corn the maze opening type bags appeared to be slightly superior to other polyethylene bags.

Seed in warehouse storage responded quite differently. Corn packaged at 8.5% moisture stored no better than did corn packaged at 11.2% moisture. Polyethylene bags were only slightly, if at all, superior to multiwall paper bags in maintaining germination. Germination of corn packaged in multiwall paper bags at 11.2% moisture was slightly lower than corn packaged in polyethylene bags after 40 months storage. Cold test emergence followed the same pattern. Moisture content of seed in multiwall paper bags increased faster and was higher at the 40 month test period than seed in polyethylene bags.

Corn did not decrease below 84% germination at either moisture content or in any bag type during 40 months storage.

Soybeans responded quite differently to packaging materials and moisture content than did corn. Beans packaged at 9.0% moisture maintained high germination (93 to 96%) throughout the 40 month storage period, regardless of bag type. Beans packaged in multiwall paper bags tended to fluctuate in moisture content and were slightly higher in moisture (1.0%) at the end of the storage period than beans packaged in polyethylene. Beans in polyethylene increased approximately 0.5% in moisture content during the storage period.

When beans were packaged at 11.2% moisture, multiwall paper bags were superior to polyethylene bags in preserving viability. Beans packaged in multiwall paper bags maintained a high germination (90%) for 32 months while beans packaged in polyethylene were considerably reduced (50 to 60%) in germination after 24 months storage. This difference can be attributed to multiwall paper bags allowing moisture to move out of the bag to a greater extent than 7 mil polyethylene. The process of respiration produces water, thus increasing the moisture content of the beans in the moisture resistant polyethylene bags, whereas this moisture would pass through the multiwall paper bags. Further evidence of this fact is that beans in unpunctured polyethylene attained a higher moisture content earlier than beans in punctured polyethylene. Moisture content of beans in punctured and unpunctured polyethylene and multiwall paper bags after 32 months storage were 11.7, 13.8 and 10.9 respectively, and after 40 months storage were 13.4, 13.3 and 12.1 respectively.

Cold test emergence decreased as time in storage decreased regardless of moisture content or bag type. The addition of a mecurial fungicide before packaging markedly improved cold test emergence through 32 months storage. Treated beans packaged at 9.4% moisture emerged 87.7% in cold test after 32 months storage when emergence was averaged for bag types, while untreated beans packaged at 9.0% moisture emerged 13.3% in cold test when emergence was averaged for bag types. This pronounced difference was not evident after 40 months storage.

Bag type had little if any influence on storability of wheat. Under warehouse conditions wheat stored at 12.6% moisture germinated 90%, 92% and 87% when packaged in punctured and unpunctured polyethylene bags and multiwall paper bags respectively after 40 months storage. Moisture content increased faster and was higher (1.5%) in multiwall paper bags than in polyethylene bags after 40 months storage.

Hot water treatment had an adverse affect on wheat storability. Initial germination was reduced 9.0% by hot water treatment. Germination after 40 months storage was 89.7% for untreated wheat when germination was averaged for bag types while hot water treated wheat germinated only 56.3% when germination was averaged for all bag types.

Seed of all kinds stored at 0°F. maintained high germination throughout the 54 month testing period. Corn, soybeans and wheat germinated 96.5, 95.0 and 92.0% respectively after 54 months storage. Germination percentages fluctuated to the same extent during the storage period, as much as 8.5% for corn 4.5% for soybeans and 7.0% for wheat. Fluctuations of this magnitude are to be expected as seed age. Cold test emergences of corn and soybeans tended to decrease as time in storage increased. This decrease, coupled with the fluctuations in germination, indicate that deterioration progressed to some extent in frozen storage.

In summary we may make the following observations:

1. Polyethylene containers are superior to cloth and multiwall paper containers in extending the storage life of seed under storage conditions of high temperature and high relative humidity.

2. There is little or no advantage of polyethylene over multiwall paper containers in packaging corn, wheat, or soybeans for storage in open warehouse conditions if conditions are similar to those encountered in central Indiana and if seed are sufficiently low in moisture at the time of storage.

3. Soybeans must be dried to approximately 9.0% moisture if they are to be packaged in moisture resistant materials.

4. Hot water treatment of wheat reduces the overall seed quality, therefore reducing storability.

5. High germination can be maintained at 0°F. for extended periods of time.

6. Seed deterioration occurs in all storage conditions, only the rate changes.

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