Soybean Seed Quality During Conditioning

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ABSTRACT

EXPERIMENTS were conducted to determine the change in soybean seed quality at various steps in conditioning. Three cultivars, two seed moistures, two temperatures and five conditioning operations were included in the experiments. Handling soybean seeds by a conventional steel-flighting auger decreased seed quality. The airscreen cleaner and the gravity separator improved quality of soybean seedlots. Seedlots below 10% moisture declined in germination as a result of conditioning. Temperature influenced the amount of splits produced during conditioning. Low moisture seedlots conditioned at −8 to −3°C temperatures declined in germination.

INTRODUCTION

The goal of conditioning is to improve the quality of harvested seed for marketing. Unfavourable conditions, howevr, sometimes prevent the conditioner from achieving this goal. Important measures of seed quality are germination and mechanical integrity of seed. It is not uncommon for certain soybean seedlots to decline in germination and increase in mechanical damage during the conditioning process. This decline in seed quality may be attributed to one or more factors: (a) mechanical damage to seeds imparted by the cleaning and handling equipment, (b) varietal susceptibility to damage, (c) conditioning seeds that are at low moistures, and (d) conditioning seeds at very cold temperatures.

A typical flow line for conditioning soybean seed is shown in Fig. 1. After harvest, soybean seeds are usually transferred from the wagon or truck to bulk storage by a conveyor. Sometimes, precleaning may take place before the seeds are put into bulk storage. At a later date, seeds are removed from the bulk storage by a conveyor and transported to a seed cleaning plant. The function of seed cleaning is to reduce weed seeds, trash materials, soil particles, and other contaminants to an acceptable level. Most soybean seed cleaning equipment is mechanical and utilizes the differences between the physical characteristics of seed and the undesirable contaminants to achieve separation. An air-screen cleaner is typically the first piece of equipment used in a soybean seed cleaning plant. The air-screen cleaner separates on the basis of size, shape, and weight. After air-screen cleaning, seeds may be passed through a spiral separator to remove nonround contaminants and shrivelled seeds. As the next step, many commercial installations utilize a gravity separator or an aspirator to upgrade seed quality. The clean seeds then may be treated and bagged. Seed damage may be caused by any of these mechanical cleaning devices or by movement of seed from one location to another during handling.

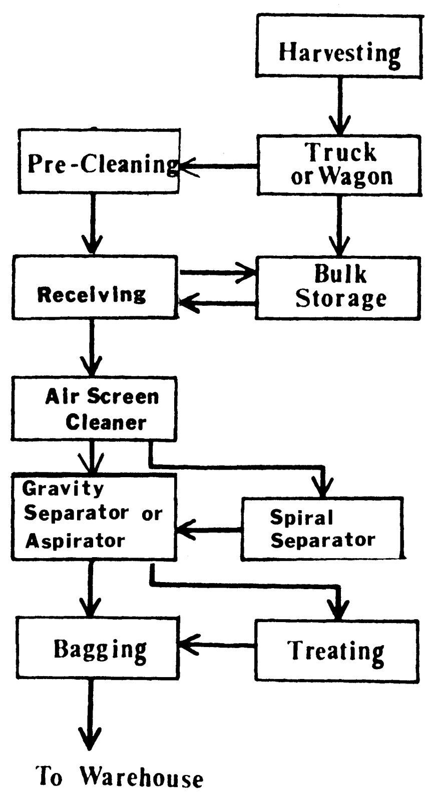

Fig. 1—Flow line for conditioning soybean seed.

Cain and Holmes (1977) evaluated soybean seed impact damage and found that seeds at 10.7% moisture sustained the least damage. Paulsen (1978) found the toughness, defined as the energy per unit volume absorbed before seedcoat rupture, to be maximum between 11 and 14% moisture range. Burris (1979) investigated the effects of temperature, seed moisture and initial mechanical damage level on seed quality when soybean seeds are dropped on a metal surface. He recommended minimizing the free-fall distances to reduce the detrimental effects to seeds.

Misra (1981) studied the locations at which seed quality loss occurred in soybean seed conditioning processes by analyzing samples at various steps in conditioning. In this study, samples were collected at different conditioning steps from ten soybean seed plants

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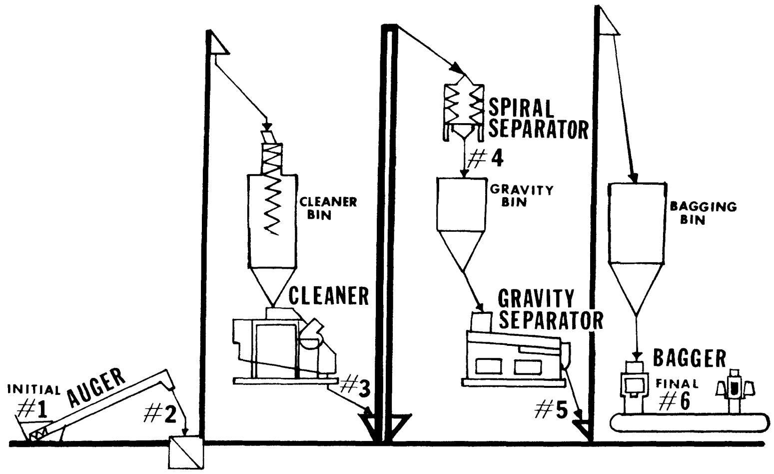

Fig. 2—The experimental set-up. (Numbers indicate locations where samples were taken.)

and analyzed. Hoffman and McDonald (1981) examined the seed quality at various steps in the conditioning process for two seedlots in a seed plant. The result from both studies indicated that, in general, handling operations decreased the seed quality and cleaning equipment upgraded the quality. The effects of moisture and temperature were not investigated in any of these studies.

OBJECTIVE

The objective of this research was to determine the change in soybean seed quality at various steps during conditioning as affected by equipment, seed moisture, and temperature.

EQUIPMENT AND PROCEDURE

Three varieties of soybean seed grown in Iowa — Corsoy, Williams, and Beeson — were used in the experiments. For each variety, two seedlots of 50 bushels each right after combining were obtained from two different seed producers. The moisture of these six seedlots ranged from 12 to 14% (wet basis). Each seedlot was subdivided into four sublots, two of which were immediately stored in plastic lined seed bags to retain their original moisture. The other two sublots were dried to approximately 9% moisture by using room air in the laboratory. The sublots corresponding to the same variety, producer, and moisture were conditioned at either 18°C (65°F) or about −18°C (0°F) ambient temperature. The seed plant temperatures for these two ambient temperatures were 18°C (65°F) and −8 to −3°C (17 to 26°F) respectively. The seed temperature approached the seed plant temperature in a few minutes of conditioning operations.

The conditioning equipment included a steel flighting auger, an air-screen cleaner, a set of spirals, a gravity separator, and a bagging system (Fig. 2). Soybean seeds were first conveyed by an auger to simulate on-farm handling of soybean seed. The auger had a tube diameter of 150 mm, a helix diameter of 133 mm, a discharge length of 3.81 m and an intake length of 300 mm. The seeds were then conveyed to the cleaner bin by a bucket elevator and were passed through a commercial air-screen cleaner with five screens and two air separations. The good seeds form the air-screen cleaner passed through a spiral separator and then a gravity separator. The gravity separator was equipped with a 16-mesh wire screen deck. The good seeds from the gravity separator were transferred to the bagging bin by a bucket elevator and were bagged by a commercial open-mouth bagger.

Samples were taken from the seedlot initially and after each conditioning operation (Fig. 2). Each sample of approximately 1 kg was obtained by cutting across the stream of seed flow several times with a plastic container. The seed quality of the samples was evaluated in terms of germination, seedcoat damage, and splits. The germination tests were conducted by the Iowa State Seed Laboratory according to the "Rules for Testing Seeds" of the Association of Official Seed Analysts (1981). Four replications of 100 seeds were planted in a kimpak substrate and germinated at 25°C for 7 days. The percentage normal seedlings was recorded as the percentage germination. The sodium hypochlorite soak procedure was used to determine seed coat damage. In this procedure, two replications of 100 seeds were soaked in a 1% sodium hypochlorite solution for ten minutes. The seeds with seed coat damage swelled visibly and were counted. The splits were obtained by passing the sample through a 10/64-in. slotted hand sieve. The material that fell through the sieve was termed 'splits', which sometimes also contained weed seeds and other undersize materials in addition to soybean splits. The percentage of splits was calculated on the basis of weight.

Data analysis was made by the Statistical Analysis System (SAS) using a split-plot experimental design. Variety was the whole-plot treatment. Moisture and temperature were split-plot treatments. Within each experimental unit of the split-plot, the effects of individual equipment were considered as repeated measurements.

RESULTS AND DISCUSSION

The first operation in this study was handling the seed by a conventional steel flighting auger. This operation, on the average, decreased the germination by 1.6%, increased the amount of splits by 1.5%, and increased the seedcoat damage by 2.2% (Table 1). The air-screen cleaner improved the average germination of soybean seedlots by 0.8%. It also removed practically all the impurities present in the seedlots. The seed quality, after

TABLE 1. SOYBEAN SEED QUALITY AT DIFFERENT STEPS DURING CONDITIONING AVERAGED ACROSS VARIETIES, MOISTURES AND TEMPERATURES.

Sequence	Germination, %	Splits, %	Seed coat damage, %
Initial	95.5_{a*}	3.23_a	7.5_d
After auger	93.9_b	4.77_b	9.7_a
After cleaner	94.7_c	0.06_c	$9.2_{a,b}$
After spiral	$94.3_{b,c}$	0.22_c	$9.4_{a,b}$
After gravity	94.8_c	0.06_c	$8.6_{b,c}$
After bagging	$94.3_{b,c}$	0.17_c	$7.9_{c,d}$

*Means with the same letters within columns do not differ significantly at the 5% level.

the air screen cleaner, did not significantly change during the rest of the conditioning operations. The spiral separator did not improve the average germination, but improved the appearances of the seedlots by removing shrivelled seeds. Although statistically insignificant, the splits during this operation increased by an average of 0.16% which were successfully removed by the gravity separator. An increase in splits was also noted during the bagging operation which may have been caused due to dropping of seeds into bagging bins.

The germination and seedcoat damage of each variety at various steps of conditioning are shown in Figs. 3 and 4, respectively. Beeson had the lowest germination and the highest seed coat damage initially and throughout the conditioning process. As expected, the gravity separator improved the seed quality for seeds of Beeson variety. This did not happen for Corsoy, because seeds of Corsoy variety were already of very high quality prior to the gravity separator operation. Seeds of Beeson also were more susceptible to breakage than the seeds of Corsoy or Williams variety when handled by an auger (Fig. 5).

The average germination during conditioning for seedlots with 12 to 14% moistures was significantly higher than the average germination of seedlots with low moistures (Table 2). The average splits produced during conditioning for low-moisture seedlots were also higher

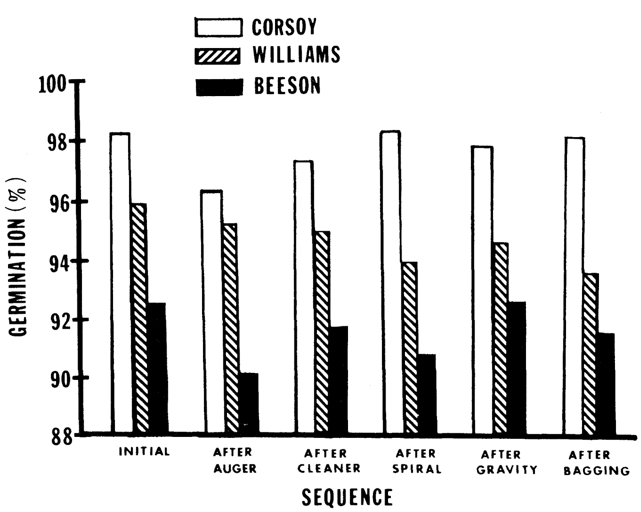

Fig. 3—Germination at various steps in conditioning for different varieties of soybean seed.

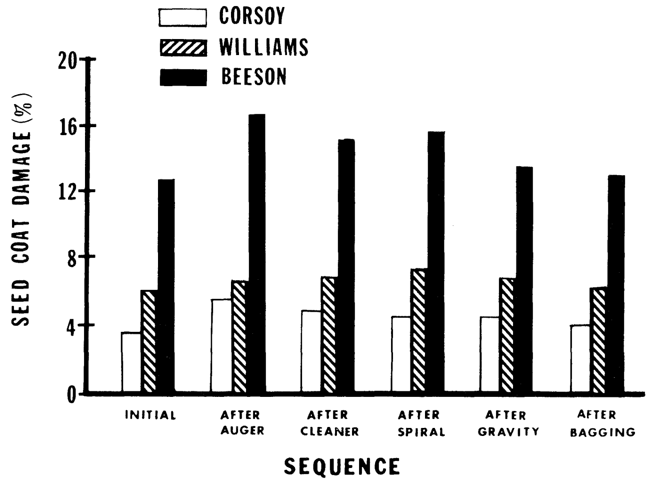

Fig. 4—Seed coat damage at various steps in conditioning for different varieties of soybean seed.

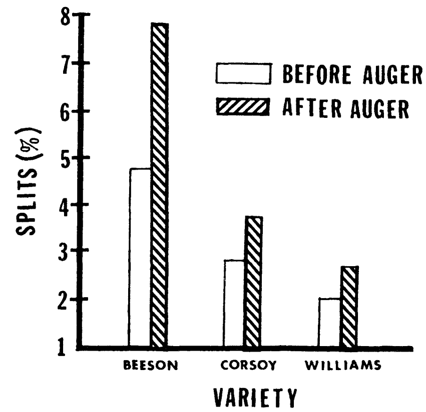

Fig. 5—Effect of handling different varieties of soybean seed by an auger.

than the splits for seedlots with moistures in the range of 12 to 14%. Seed moisture content did not appreciably influence seedcoat damage during conditioning.

Temperature during conditioning did not have a major influence on soybean seed germination or seedcoat damage (Table 3). More splits resulted from conditioning soybean seeds at −8 to −3°C (17 to 26°F) temperatures than at temperatures of about 18°C (65°F). This was primarily because more splits were produced when the auger was operated at cold temperatures than at 18°C (65°F) temperature (Fig. 6).

Significant interaction of conditioning equipment with moistures was found for germination (Fig. 7). The seedlots with 12 to 14% moistures essentially retained their germination whereas the low moisture seedlots lost an average of over 2% germination. The difference between the two moistures became more pronounced as

TABLE 2. EFFECT OF MOISTURE ON SOYBEAN SEED QUALITY DURING CONDITIONING AVERAGED ACROSS VARIETY, TEMPERATURE AND CONDITIONING OPERATIONS.

Moisture, %	Germination, %	Splits, %	Seed coat damage, %
12-14	95.5a*	1.28a	8.6a
<10	93.7b	1.56b	8.8a

*Means with the same letters within columns do not differ significantly at the 5% level.

TABLE 3. EFFECT OF TEMPERATURE ON SOYBEAN SEED QUALITY DURING CONDITIONING AVERAGED ACROSS VARIETY, MOISTURE AND CONDITIONING OPERATIONS.

Temperature, °C	Germination, %	Splits, %	Seed coat damage, %
18	94.9a*	1.26a	8.4a
-18	94.3a	1.58b	9.0a

*Means with the same letters within columns do not differ significantly at the 5% level.

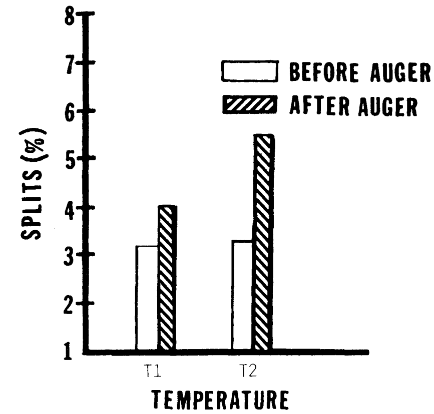

Fig. 6—Effect of auger handling on soybean seed splits as affected by temperatures. (T1 — Ambient and seed temperature: 18°C and T2 — Ambient temperature of −18°C for which seed temperature ranged from −8 to −3°C).

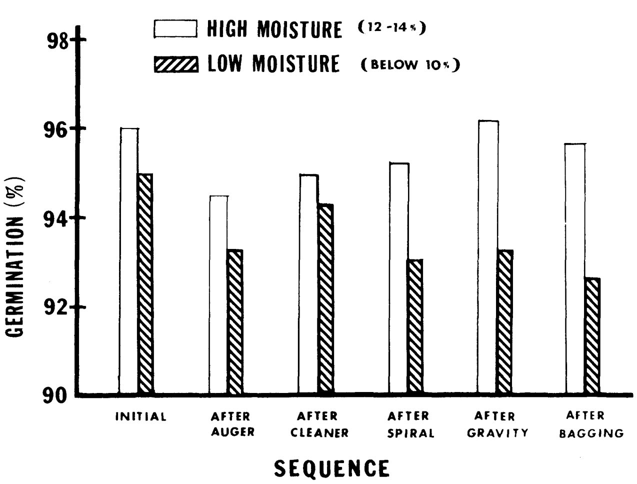

Fig. 7—Effect of seed moisture and various conditioning operations on germination of soybean seed.

the conditioning progressed beyond the air-screen cleaner. Seeds of Beeson cultivar were more affected by moistures than seeds of Corsoy or Williams variety (Fig. 8). Low-moisture seedlots conditioned at cold temperatures had the lowest final germination of any treatment, declining by over 4 percent (Table 4).

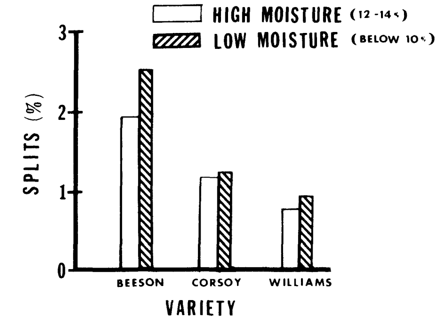

Fig. 8—Effect of seed moisture on soybean seed splits during conditioning for different varieties of soybean seed.

TABLE 4. EFFECT OF MOISTURE AND TEMPERATURE ON SOYBEAN SEED GERMINATION DURING CONDITIONING OPERATIONS AVERAGED ACROSS VARIETIES.

	Germination, %			
Conditioning operations	M:12-14% T:18°C	M:12-14% T:-18°C*	M:<10% T:18°C	M:<10% T:-18°C*
Initial	96.2	95.8	94.8	95.3
After Auger	95.2	93.8	93.7	93.0
After Cleaner	95.3	94.8	94.5	94.2
After Spiral	95.7	95.0	93.3	93.0
After Gravity	96.0	96.5	94.0	92.8
After Bagging	95.7	95.8	94.3	91.2

M = Moisture
T = Temperature
*Ambient temperature for which the seed temperature ranged from -8 to -3°C.

CONCLUSIONS

1. Handling soybean seed by a conventional steel-flighting auger significantly decreased germination, and increased splits and seedcoat damage.
2. Among the sequences tested, the air-screen cleaner and the gravity separator operations caused increase in seed quality.
3. Soybean seeds conditioned at 12 to 14% moistures retained germination whereas seedlots below 10% moisture declined in germination during conditioning.
4. Temperature during conditioning did not have a major influence on soybean seed germination or seedcoat damage but did influence the amount of splits produced.
5. Low-moisture (below 10%) seedlots conditioned at −8 to −3°C temperatures declined in germination.

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