

Drying Temperatures and Storage Problems of Sugar Beet Seeds

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Sugar beet seed for Michigan growers is grown in the West and shipped into Michigan for processing and planting. All of the two-million pounds of sugar beet seed for the eastern sugar beet producing area, which includes Michigan, is grown in California and Oregon. (1) During transportation and storage the moisture content of the seeds changes because of humidity and temperature variations. An increase in moisture content above eleven or twelve percent occurs in Michigan seed during some years, causing difficulty in decorticating the seed. The engineering properties of sugar beet seeds were determined to aid in solving the problem of excess moisture. All tests were run using sugar beet seeds of variety 216 x 226 from the 1953 harvest, initially at 13 to 14.5 percent (wet basis) moisture. Conventional air-oven methods were used for making the moisture determinations.

Equilibrium Moisture Content

Sugar beet seeds will go to a certain moisture content, known as the equilibrium moisture content, depending upon the temperature and relative humidity of the surrounding atmosphere. The equilibrium data can be used to determine the moisture content changes which will take place during transporting and storing. Each sample of seeds of approximately 10 grams was placed in a glass container in which the relative humidity was maintained by a saturated-salt solution. Salts were selected which maintained approximately the same relative humidity at the different test temperatures as follows:

Relative Humidity, Percent	Chemical (salt)
90	Ba Cl ₂ ·2H ₂ O Barium chloride
75	Na Cl Common salt
53	Mn Cl ₂ ·4H ₂ O Manganese chloride

The glass container for each sample was then placed in temperature-controlled wooden boxes which maintained 100°, 85°, 60°, and 40° F. ± 1° F. With four different temperatures and three different relative humidities, there were 12 samples in a test. The test was run three times. There was a maximum variation of the equilibrium values of approximately three-fourths percent moisture from those reported in Figure 1.

Germination of Sugar Beet Seeds

If heated air is to be used for drying sugar beet seeds, it is important to know the effect of the heated air on the germination. Tests were run with the seeds in a thermostatically-controlled oven at 100°, 110°, 120°, 130°, and 140° F., with exposure times of 1, 2, 3, 4, 5, and 6 hours at each of these temperatures. Duplicate tests were made for each time and

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² Numbers in parentheses refer to literature cited.

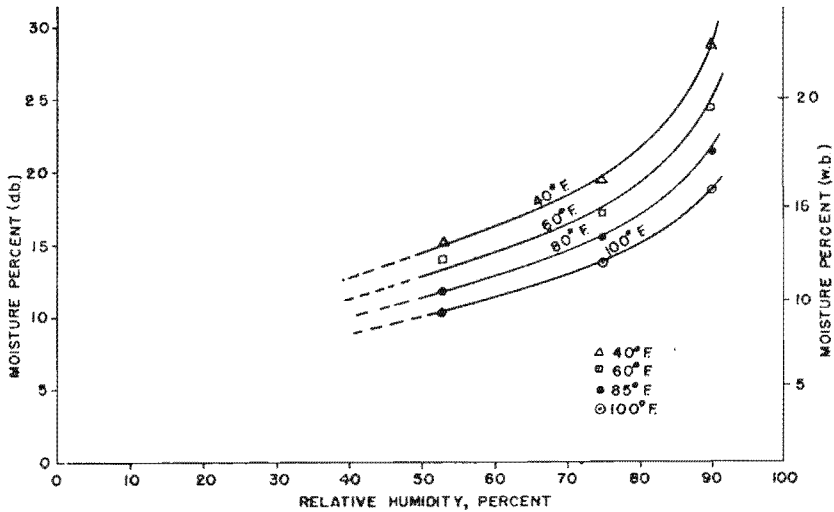


Figure 1.—Equilibrium moisture content of sugar beet seeds (216 x 226).

temperature. Two samples were taken from each of the original samples giving a total of four samples for three-day and seven-day germination tests. The time of exposure began as soon as the seeds were within 10° F. of the oven temperature. At the end of each exposure period the samples were air cooled to room temperature, weighed accurately, and all except 50 grams used for germination tests. The 50-gram sample was used for determining the moisture content. From the information obtained by using a mercury thermometer and thermocouples, it appears that the sample temperature was 1° to 5° F. below the oven temperature.

The three- and seven-day germination tests did not show impairment with oven temperatures of 110° F. for 2 hours and 120° F. for an exposure of 1 hour. For exposures longer than 2 hours, at oven temperatures of 110° and 120° F., the germination was reduced to 47 percent for the three-day and 52 percent for the seven-day germination tests for 6 hours at 110° F. For exposures at 130° and 140° F., the germination was impaired for exposures of 1 hour and longer. Subsequent tests at 115°, 116°, 117°, 118° F. did not reduce the seven-day germination, but did decrease the three-day germination, particularly at 117° and 118° F. for 2 hour exposure and longer.

Air Flow-Static Pressure-Depth Tests

A rectangular bin 8 feet high with a cross-section of 20 inch by 20 inch connected to a variable-speed fan was used for making the air-flow tests. The quantity of air was determined on the discharge side of the bin with a vane anemometer. Air flow readings were taken with sugar beet seeds at a moisture content of 13.5 percent, wet basis, at one-foot intervals from one to seven-foot depth in the bin. Static pressure data were obtained from a pressure tap near the entrance of the air to the bin. The relationship of

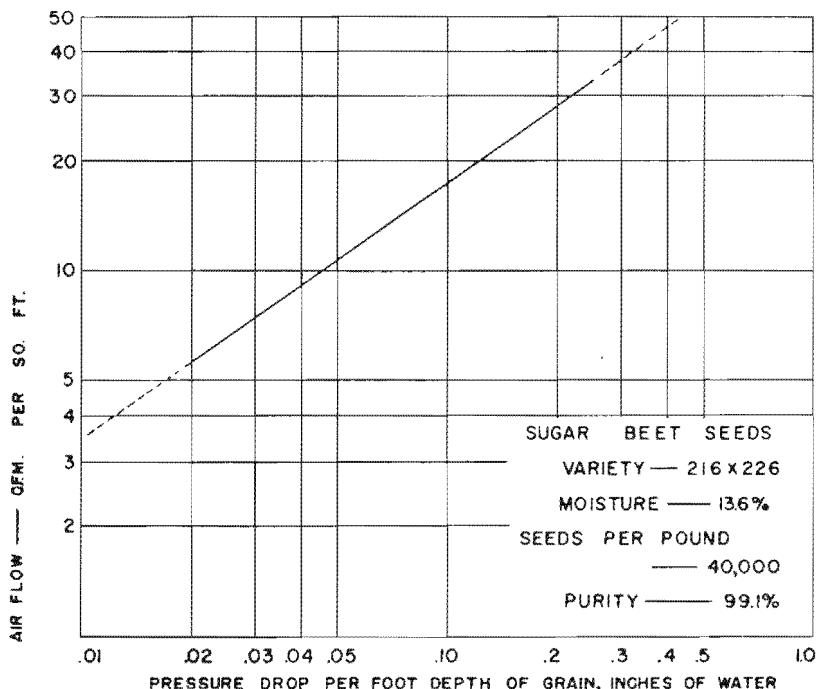


Figure 2.—Resistance of sugar beet seeds to air flow.

air flow in CFM per square foot to the static pressure in inches of water for a one-foot depth of seeds is shown in Figure 2. The data obtained for each one-foot depth were averaged to obtain the line shown in Figure 2. To obtain the static pressure for any other depth, multiply the value for one foot times the depth in feet. Thus, for a three-foot depth of seeds the static pressure for a given air flow would be three times the value obtained from Figure 2. The air-flow data represents the average values obtained when filling and emptying the bin in one-foot increments. Thus, the static pressure values given in the graph are slightly higher than the values which would be received for loose fill only. At a given air flow for sugar beet seeds the static pressure is slightly less than for soybeans and shelled corn. The air flow data are valuable for specifying a fan for moving air through deep layers of sugar beet seeds.

Exposed Drying Rates

The exposed drying rate of a product can be used for determining the effect of temperature and air flow on drying. A thin layer of seeds (the thickness of the diameter of the seed) was placed on the bottom of a three-inch diameter drying chamber. Heated, forced air was supplied by an electric hair dryer. The temperature of the air was changed by varying the resistance of the heater element in the hair dryer. The seed-drying chamber was removed and weighed periodically to determine the amount

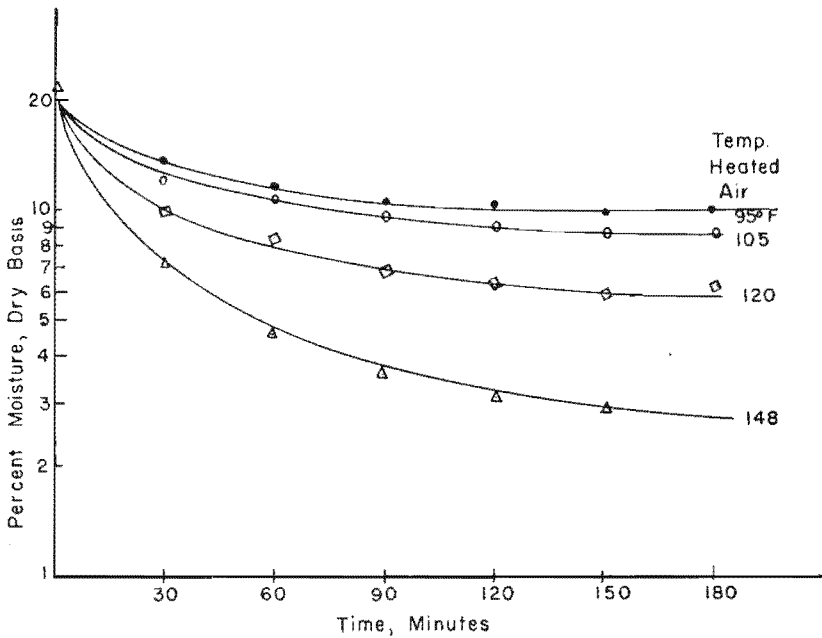


Figure 3.—Exposed drying rate of sugar beet seeds. Original unheated air had: RH-60 percent, average 78° F., air flow—90 feet per minute.

of moisture removed during any given time period. A three-inch diameter-type velocity meter was placed on the top of the chamber to determine air velocity. Both the original and final moisture contents were determined by a gravity oven-dry analysis with the oven set at 212° F. for three days. The exposed drying rates are shown in Figure 3. Air originally at 78° F. and 60 percent relative humidity was heated to 95°, 105°, 120°, and 148° F. Note that a logarithm scale is used for representing the percent of moisture on a dry basis.

Layer Drying

Under practical drying conditions the seeds would be placed in depths greater than a one-seed diameter. Tests were run using a 4-inch depth of beet seeds. The average percent moisture after various periods of drying with heated air is shown in Figure 4, for drying air at 100°, 120°, 143°, 195° F.

Coefficient of Friction

The coefficient of friction of sugar beet seeds at 6.3 and 16.5 percent moisture on several surfaces was obtained by placing the seeds in a small frame, which did not touch the surface being tested, and tilting the table until the seeds slid on the required surface. The tangent of the angle at which the seeds will just slide is the coefficient of friction. The data in Table I are the average of five tests.

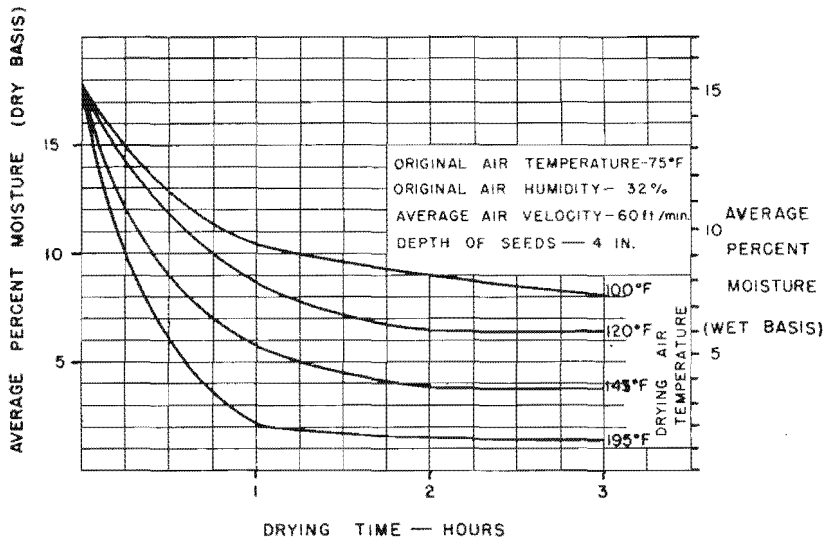


Figure 4.—Drying sugar beet seeds in four-inch layer in laboratory bin.

Table 1.—Coefficient of Friction of Sugar Beet Seeds.

Treatment	Percent moisture 6.3	Wet basis 16.5
Seeds on seeds	0.78	0.81
Seeds on concrete (wood float)	0.81	0.84
Seeds on finished plywood (with grain)	0.69	0.71
Seeds on finished plywood (across grain)	0.70	0.75
Seeds on smooth galvanized iron	0.50	0.55
Seeds on oxidized galvanized iron	0.66	0.71
Seeds on rough cut lumber	0.90	0.97

Conclusions

1. Sugar beet seeds will go to a moisture content above 12 percent (w.b.) as the relative humidity goes above 50 percent and the temperature below 60° F.

2. To remove excess moisture with heated air, 110° F. air is the maximum temperature which should be used if the seeds are exposed to the heat for over 1 hour. The exposure time will depend on the moisture content of the product at a given air flow. To reduce a 4-inch layer of seeds from 14.5 to 11 percent moisture (w.b.) with air at 60 feet per minute required 29 minutes. If accurate controls were used on the heater, and seeds cooled quickly after drying so that the seeds were not heated for more than 1 hour, 120° F. air could be used to dry seeds with 14.5 percent moisture in 23 minutes.

3. The static pressure at a given air flow through the seeds is slightly less than for shelled corn. Similar drying procedures and equipment can be used for sugar beet seeds and shelled corn.

4. The coefficient of friction of sugar beet seeds is considerably higher than for the common cereal grains. More slope is needed to provide movement of seeds in pipes and on various surfaces.

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Reference

- (1) REEVE, PERC A. 1954. Sugar beet seed production. Sugar Beet Journal, 19: 1-2, September.
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