Seed Segmenting Devices

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The development of a single germ, sugar-beet seedball is the first essential for a mechanized program of sugar-beet production. Besides this there is the necessity to maintain seed of high germination, to treat seed for protection in infested soils, and to utilize planting equipment for uniform distribution of the seed-

Sugar-beet seedballs contain, on the average, more than one germ each. This means that regular seed, when planted, may produce from none to several seedlings per seedball, making finger thinning imperative in order to obtain a singled stand. A reduction in the number of germs per seedball will materially reduce the hand labor of thinning. Furthermore, if the beets are to be thinned mechanically, or with a long-handled hoe, the percentage of singles will be greatly increased. Any method that gives a higher percentage of single plants will be reflected in a mechanical-harvesting system employing ground topping. Beets in multiple combinations seriously affect the quality of mechanical topping.

Discussion of Experimental Machines

Attempts have been made in the past to produce a single-germ seedball by plant-breeding methods. The results, to date, have not been satisfactory. Dr. W. Knolle of the Institute of Land Machines at Halle, Germany, developed a process prior to 1940 for cracking sugar-beet seed in an endeavor to reduce the number of germs per seedball. The process was immediately commercialized and a limited amount of seed was made available during 1940. Correspondence with the Director of the Experiment Station at Halle did not yield any technical information on the process. Therefore, a similar investigation was started at the University of California in an attempt to produce a single-germ unit by mechanical means.

A preliminary machine was built in February 1941 for breaking the sugar-beet seedball into segments, each containing approximately one germ. A Hormel-Wagner belt sander, which was on hand, was used as a base machine for developing the process. This machine consisted of 2 horizontal 4-inch pulleys mounted on 12-inch centers. An endless abrasive belt, 4 inches wide and 361/4 inches long, operated at 1,350 feet per minute over the pulleys. The belt was backed up between pulleys by a flat table 5 inches wide and 10^4 inches long. Belts with various sizes of grit were available for the machine. The best performance resulted from the use of belts having grit sizes 24 and 30.

A hopper was added to conduct the seed to the belt. An adjustable breaker strip or shear bar 3/8 x 11/2 x 5 inches was attached

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to the table on the discharge side of the hopper. Various clearances between the shear bar and belt were tried. When the original sample was divided by grading over a 13/64-inch screen, a clearance of 0.072 inch gave the best results for the smaller seed while a clearance of 0.092 inch was used for the larger seed. However, early trials indicated that sack-run seed could be sheared with a clearance of approximately 0.080 inch.

During the segmenting process the seed is engaged by the rough belt and carried under the shear bar. Some rolling apparently takes place so that when the seed is crowded under the shear bar it rolls until the applied force is directed through the weak section of the seedball between flower clusters. The seedballs are actually broken between the seed cells, giving small flakes of corky material enclosing the cell and germ. The approximate size of the flake is 3/32 inch thick and 3/16 inch in diameter. In addition to the reduction in size of the segment as compared to whole seed some damage is evident. In some instances the seed is exposed because of the removal of the corky sepals and portions of the pericarp. Occasionally a part of the seedcoat is removed and, in some cases, the seed is broken exposing the endosperm. In general the segmented seed still has the appearance of whole seed, except for size. Due to the change in size the eurface area is approximately twice as great as an equal weight of the original seed.

While the preliminary machine gave satisfactory results, the capacity was only 100 pounds (whole) seed per hour, and the life of a belt 20 minutes. In spite of its limitations, several hundred pounds of seed were sheared for experimental plantings.

Another Machine Developed

Later a second machine was built to overcome the defects of the preliminary unit. The second unit made use of a 20-grit, silicon-carbide, vitrified stone 2 inches wide and 10 inches in diameter (Norton Crystolon wheel number 3720Q) mounted on a horizontal shaft supported by 2 sealed ball bearings. A 3/4 horsepower electric motor was used for power. An adjustable shear bar (made of chrome-molybdenum No. 4145 steel—heat treated) 1/2 x 1 and 5/16 x 2 inches, with the leading edge slightly relieved to facilitate feeding of the seed, was used. Any carbon steel that can be hardened can no doubt be used for the shear bar. Early experiences with mild steel showed too rapid wear. A hopper conducted the seed to the wheel. The principle of operation was similar to the original machine in that the stone carried the seed past the shear bar.

The present machine, which has an operating width of 17/8 inches, has a capacity of approximately 400 pounds (whole) seed per hour when operating at a peripheral speed of 2,000 feet per minute. Variations in speed from 1,500 to 3,000 feet per minute gave approximately the same capacity.

A hand screen having round holes 8/64 inch in diameter has been used for making preliminary determinations to be used in setting the shear bar. Best results have been obtained when 50 to 60 percent of the sheared sample was retained on this size of screen. The adjustment of the shear bar is quite critical, in that changes of only 3 to 5 thousandths of an inch in clearance materially affect the performance. Once the machine is set changes due to wear are slow.

Grading and Cleaning of Sheared Product

A Clipper type of fanning mill was used for grading and cleaning the sheared product. An 11/64-inch sieve on top scalped off any large seed that should be rerun, and an 8/64-inch screen used below collected the part of the sample to be retained. With the above screen arrangement, the maximum variation in size of seed was 3/64 inch. For some varieties of seed the sample passing through the 8/64-ineh screen was regraded over a 6/64-inch screen to give a second size that could be used. However, more germination trials must be run in order to be sure of this smaller seed.

During the shearing and cleaning operation, the sample of seed is reduced to about 1/2 of the original weight. However, the sheared sample has approximately twice as many seed segments per unit weight as were in the original sample. For example, 1 lot of (U. S. 15) seed contained 5,804 seedballs per 100 grams before shearing and **10,212** units per 100 grams after shearing (approximately 46,000 seed units per pound). Therefore, the actual recovery of seed units amounts to 80 to 100 percent of the number in the original sample. Table 1 shows the results of cleaning, grading and germination of a sample of sheared seed (U. S. 12). The sample was cleaned and graded in a Clipper Cleaner. The 4.4 percent retained on the 11/64-inch sieve would normally be returned for reshearing. However, for comparison, this portion was carried through germination trials with the balance of the sample. The portion collected between the **1**1/64-inch and 8/64-inch sieves represented 42.2 percent by weight. When calculated on the basis of number of seeds per unit weight, the sheared sample contained 83 percent as many units as were in the original sample. Sheared seed falling into this grade has been used in most of the preliminary planting trials. The portion passing through the 8/64-inch sieve and retained on a 6/64-inch screen shows a low germination. However, some better method of recovery may be possible for removing the non-viable seed. If the size of the sample were reduced to 6 percent through further cleaning, this final portion alone would yield approximately 20 percent as many seed units as were contained in the original sample. The free germs represent 20 percent as many seed units as there were seedballs before shearing. Actually, in this test, 98 percent of the free germs grew; however, only 71 percent were reported as normal plants. The balance showed results of mechanical injury. Nothing

Table 1.—Results of cleaning, grading and germination of a sample of sheared beet seed (U. S. 12); shear bar set for clearance of .088 inch.

Grade-sieve	Percentage retained	Seeds 100 gr.	Percentage germination	Seedlings per ball
Larger than 11/64-inch sieve	4.4	6,295	94.0	1.76
Through 11/64 over 8/64-inch screen	42.2	10,331	82.1	1.18
Through 8/64 over 6/64-inch screen	10.8	17,154	63.8	1.05
Free germs	2.9	36,131	71.0	1.9
Dust and screenings	39.7			
Original sample		5,248	84.5	2.21

has been done, to date, toward the separation of the damaged germs from the undamaged ones.

A Sutton Steel and Steel Gravity Separator was used for the final grading of some of the first samples that were sheared. This machine was used after the seed had received a light cleaning over the Clipper machine. Its use has been discontinued due to its low capacity (approximately 100 pounds per hour). However, the results are worthy of mention so that the report on one run will be included in this paper. The sample (U. S. 933) used for shearing had an original germination of 88.5 percent. After the seed was sheared and had received a preliminary cleaning, the increment retained on the 8/64-inch screen was run over the gravity separator.

Table 2.—Germination results of sheared seed graded on a gravity separator; germination of original seed S8.5 percent.

Spout	Percentage of sample	Percentage of germination
1	0.9	94.0
2	24.1	91.5
3	34.6	83.0
4	25.4	72.0
5	6.1	36.5
6	2.9	36.0

The sample of sheared seed, after preliminary cleaning, contained 108.8 percent as many seed units as were contained in the original sample. After grading over the gravity separator and the material collected from spouts 5 and 6 was eliminated, the sample still contained 99 percent as many seed units as were in the original sample. The germination of the material coming from the first 4 spouts was 82.5 percent as compared to 88.5 percent in the original sample, and the relative number of seedlings per seedball were 1.13 for the sheared lot as compared to 1.92 for the original sample. Later, a heavier air blast applied to the seed in the preliminary cleaning gave final results comparable with the above.

Other phases of beet production utilizing segmented seed to be discussed are; Seed treatment, single seedball planters, mechanical blocking and thinning, and segmenting seed while planting.