Processing and Drill Performance of Monogerm Beet Seed

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Many attempts have been made in the United States since 1935 to reduce the hand labor required to thin beets to satisfactory field stand. Only partial success has been obtained, however, because until 1948 all sugar beet seed was multigerm in character. During the period 1940-1945 Bainer (1, 2)[2] developed segmenting and decorticating machines for multigerm seed, and this seed when graded to size and planted in good drills greatly reduced thinning labor. Possibility of a further reduction in labor came in 1948 with the discovery of monogerm beet seed by Savitsky (4).

For precision planting, monogerm seed must be polished to remove adhering flower parts before grading to size. Various types of polishers have been used—beet seed decorticators, barley debearders, and specially constructed polishers (3). The purpose of this paper is to report on the processing of monogerm seed using the Engleburg rice huller, the grading of seed for size, and the drillability of this seed in three makes of drills.

Monogerm Seed Processing and Grading

In 1960 an Engleburg huller was installed in the Western Seed Production Corporation cleaning plant at Cashion, Arizona, and 25 test runs were made, using monogerm varieties produced in this area. Data from these 25 runs are found in Table 1.

Table 1.—Characteristics of natural and polished monogerm seed.

Character	Type of Seed	
	Natural	Polished
Seeds per Pound	49,405	62,716
Percent Germination	82.7	82.4
Weight Per Bushel (pounds)	21.06	33.85
Percent Polishing Loss (by weight)		19.27

American #3 N polished seed had similar characteristics to those listed in Table 1 and was selected for size grading and planter tests. Seed of this variety was graded over round-hole screens with size perforations of 6/64", 7/64", 8/64", 9/64" and 10/64"; 200 pounds were sent to The Simon-Carter Company of Minneapolis, Minnesota for two dimensional gradings—diameter

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[2] Numbers in parentheses refer to literature cited.

and thickness. The diameter sizes were the same as those listed above, and the thickness grades were obtained using slot screens with the following widths of slot: 4/64", 5/64", 6/64" and 7/64". The proportions falling into the various classes for the two dimensions separately, are given in Table 2.

Table 2.—Percent of seeds by weight divided into 1/64 inch fractions for both diameter and thickness.

Diameter	-6	6-7	7-8	8-9	9-10	+10	Total
	5.8	16.5	32.83	24.08	12.02	8.07	100%

85.43%

Thickness	-4	3.81	
	4-5	43.44	> 72.25%
	5-6	28.81	
	6-7	8.11	
	+7	1.26	
		85.43	

As shown in Table 2, 85.43 percent of the polished seed was from 6 to 10/64 inches in diameter, and of this size range, 72.25 percent was from 4 to 6/64's inches in thickness.

The characteristics of twelve of the two dimensional fractions are given in Table 3.

Table 3.—Percent recovery, percent germination and percent multigerm in twelve sizes of polished monogerm seed.

Thickness 64th inch	Diameter 64th inch	Percent multigerm	Percent germination	Percent recovery
-4	6-10	0	25.0	3.81
4-5	6-7	0	90.3	12.50
4-5	7-8	0	90.2	21.00
4-5	8-10	0	90.0	9.94
5-6	6-7	29.0	86.5	1.28
5-6	7-8	12.0	91.0	9.07
5-6	8-9	2.0	89.0	11.86
5-6	9-10	1.5	90.0	6.60
6-7	6-10	20-95	90.2	8.11
+7	——	100	90.6	1.26
	-6	——	——	5.80
	+10	——	——	8.77
				100.00

From these data, the following observations can be made:

1. -4/64" thickness seed was too low in germination to be used.

2. The 4 to 5/64" thickness sizes were 100 percent monogerm, regardless of diameter size.

3. The 5 to 6/64" thickness size contained some double germ seed, with the percentage decreasing with increasing seed diameter.

4. The 6+/64" thickness sizes were mostly double germ.

5. Seed of 6-7/64" diameter and 5-6 thickness is not usable because this seed being nearly round, has a high percentage of doubles and triples.

6. In regard to thickness, the usable portion of the seed was in the 4 to 6/64" range.

7. Diameter sizes 6-8 and 8-10/64" appeared to be the most usable fractions.

Figure 1.—Picture of drill test rack mounted with units of three makes of drills used in experiments at Rocky Ford, Colorado.

Drill Experiments

With two polished monogerm seed lots on hand, one of which was diameter graded, and the other graded for both diameter and thickness, drill tests were conducted with one unit of each of the following three makes of drills: International 185, John Deere 70, and the Milton. All three drill units were set up on a "rack" and driven at as nearly the same speed as possible (See Figure 1). The drill testing consisted of three 5-minute test runs averaged to obtain the percent cell fill. The method used for determining cell fill is outlined as follows:

1. Obtain the number of seeds per gram.

2. Plant the seed through the drill for 5 minutes and weigh in grams.

3. Convert the weight of seeds planted to number of seeds planted.

4. Determine the number of cells in the seed plate which pass the "cutoff" in the drill can in 5 minutes.

5. Calculate the cell fill by dividing the number of seeds planted, by the number of cells available, and express in percent.

It is well known that errors can be obtained by the use of this method of calculating cell fill, since if one cell receives two seeds, and one receives no seed, the result is 100% cell fill. However, the error is minimized to the point of little importance when accurately sized seed is planted through plate cells of appropriate diameter and thickness. If seed size is not correct for the cell size of the drill plate, excessive grinding of seed will be obtained.

The first drill tests were made on seed graded for diameter only, using a variety of plate cell sizes and thicknesses, using the International and the John Deere. These tests were run on seed sized at 1/64 inch size differences, and on combinations of two sizes. In all of these preliminary trials excessive grinding was obtained, with the exception of the 6 to 7/64" diameter seed. Close inspection of the seed sizes and shapes indicated that seed thickness was of more importance than had been expected.

Most of the usable dimensional graded seed (Table 3) fell into 3 sizes: 6 to 7/64" diameter and 4 to 5/64" thickness; 7 to 8/64" diameter and 4 to 5/64" thickness; and 8 to 9/64" diameter and 5 to 6/64" thickness. After repeated drill tests it became clear that two thickness grades could not be combined and still produce the best precision planting. However, within the two thickness grades a tolerance of 2/64" diameter size was possible. The sizes finally determined were 4 to 5/64" thickness and 6 to 8/64" in diameter and 5-6/64" thickness and 8-10/64" in diameter. The smaller seed was designated as Number 1 and the larger as Number 2. Percent recovery, seeds per pound and percent germination are given in Table 4 for these sizes and also on the polished and unpolished seed.

The change in seed characteristics made from polished seed with the Engleburg huller is clearly indicated in Table 4. Weight per bushel was greatly increased by polishing as well as by grading to size. Percent germination was increased from 87.0 percent for the unpolished seed to 92.5 and 94.8 for the No. 1 and No. 2

Table 4.—Seed characteristics of unpolished seed, polished seed and the two dimensional sizes designated as No. 1 and No. 2 (Am #3N).

Seed type	Seeds per pound	Weight per bushel	Percent germination	Percent recovery
Unpolished	49,405	21.1	87.0	100.0
Polished	62.716	33.9	88.0	80.27
No. 1	72,000	43.5	92.5	26.87) 41.69*
No. 2	44,500	36.7	94.8	14.82)

* on unpolished basis

usable fractions, respectively. A comparison of number of seeds per pound indicates that the large seed in the original sample may not have been polished as much as the small seed.

Results of Drill Tests on No. 1 and No. 2 Polished Seed

In the testing of the drills, only certain seed plates were available in cell diameter size and thickness for the International and John Deere drills. Since International plates were easily machined to various thicknesses this drill was used extensively. In no case were cell diameters changed on plates of either drill.

Since both International and John Deere drills performed very similarly, some of the data on cell fill is a combination of the results obtained with both drills. Table 5 gives the percent cell fill data using seed plates of .083 thickness on No. 1 seed with different cell diameters, travel rates, and planting rates.

Table 5.—Percent cell fill on No. 1 seed with .083 seed plate thickness with different cell diameters, travel rates and planting rates.

(John Deere and International Combined)

Diameter	Miles per hour	Seeds planted per row foot	Percent cell fill
8½/64"	2.5	6.0	90.0
	2.5	8.5	85.5
(.133")	3.0	6.0	87.7
	3.0	8.5	84.5
9/64"	2.5	6.0	100.6
	2.5	8.5	98.1
(.141")	3.0	6.0	100.1
	3.0	8.5	98.3

In Table 5 many comparisons can be made; but the first conclusion to be reached is that cells of 8½/64" diameter are not large enough for seed with maximum diameter of 8/64". In speed of travel, 2.5 miles per hour was slightly better than 3.0, especially when cell size of 8½/64" was used. As an average, a planting rate of 6 seeds per foot of row gave a percent cell fill of 94.6 as compared with 91.6 for the planting rates of 8.5 seeds per foot of row. This result is to be expected, since increased planting rate is obtained by increased speed of seed plate travel, which is the equivalent of increasing the miles per hour travel rate. Thus if 8.5 seeds are planted per foot of row at 2.5 miles per hour instead of 6 seeds, seed plate travel converted to miles per hour travel rate will be: $\frac{8.5}{6.0} \times \frac{2.5}{1} =$ 3.54 miles per hour. The data given in Table 5 indicate that very satisfactory cell fill was obtained with plates of .083 thickness and cell diameter of 9/64" when planting rate was 6 seeds per foot of row at both 2.5 and 3.0 miles per hour travel rate.

Table 6.—The effect of cell size and shape on percent cell fill with the Milton Drill.

Type of seed wheel			Miles	
Size of cell in 64th inch	Number of cells	Seeds planted per row foot	per hour travel	Percent cell fill
8½-5½-7½	140	6.0	2.79	92.6
8-6-7	180	6.0	2.94	98.9
8-6-8	140	6.0	2.79	100.4

The effect of cell size on percent cell fill was also determined for the Milton drill using No. 1 sized sized seed (Table 6).

The effect of plate thickness on percent cell fill was also studied. Due to the difficulty in obtaining seed plates in the various thicknesses, these tests were limited to No. 2 seed (8 to 10/64″ diameter, 5 to 6/64″ thickness), using the International drill. Cell diameter for these tests was 11/64″. The results are given in Table 7.

Table 7.—Comparisons of plate thickness on percent cell fill, with No. 2 seed.

Plate thickness in inches	Cell diameter 64th inch	Miles per hour	Percent cell fill
.090	11/64	2.96	82.0
.103	11/64	2.96	100.4
.110	11/64	2.96	111.5

These results indicate the great importance of seed plate thickness on percent cell fill. In this test, a difference in plate thickness of .020″ made a difference of 29.5 percent cell fill.

In Table 5 data were given on the effect of speed of travel on percent cell fill. This was investigated further with all three test drills using No. 1 seed, and the John Deere and International on No. 2 seed. The plates used for the two seed sizes were those which had been found to be satisfactory for both cell size and thickness and are listed as follows:

Seed Type	Drill	Cell Diameter	Thickness
No. 1	John Deere	9/64″	.083″
	International	9/64″	.083″
	Milton	8-6-8/64″	
No. 2	John Deere	11/64″	.103″
	International	11/64″	.103″

Tables 8 and 9 give the effect of rate of travel for both seed sizes at 6 seeds per row foot planting rate, on percent cell fill.

As shown in Table 8, all three drills planting No. 1 seed showed a significant reduction in percent cell fill for each increased planting speed. In Table 9 the data show the same trend with No. 2 seed, but with little difference between the two lower speeds. With speeds nearing 4 miles per hour there was a definite drop in percent cell fill.

Table 8.—The effect of travel speed with three different drills planting six seeds per row foot of No. 1 size on percent cell fill.

Miles per hour	Drill make	Percent cell fill
2.56	International	103.7
3.01		101.0
3.91		99.5
2.56	John Deere	101.1
2.96		99.8
3.89		96.4
2.48	Milton	99.5
2.92		96.4
3.83		88.7
F. Value	89.5	
Sign. Diff. (19:1)		1.21

Table 9.—The effect of travel speed with two different drills planting six seeds per row foot of No. 2 size on percent cell fill.

Miles per hour	Drill make	Percent cell fill
2.56	International	100.8
3.01		100.4
3.91		96.4
2.56	John Deere	101.0
2.96		100.3
3.89		96.5
F. Value	13.23	
Sign. Diff. (19:1)		.46

Summary of Results

1. Seed used in these experiments was polished with the Engleburg rice huller and graded to size (a) over round hole perforated screens for diameter and (b) over round hole and slot screens for diameter and thickness.

2. Preliminary drill tests indicated that both diameter and thickness grading was necessary for accurate planting of seed.

3. Two sizes of polished seed, representing 41.7 percent of the total per acre yield of seed were considered satisfactory for precision planting:

No. 1—6 to 8/64 inch in diameter; 4 to 5/64 inch in thickness

No. 2—8 to 10/64 inch in diameter; 5 to 6/64 inch in thickness.

4. Drill tests of these two sizes indicated that thickness of seed plate was most important. Cell diameter was also important.

5. Travel speed of approximately 3 miles per hour gave approximately 100 percent cell fill with three beet seed drills when equipped with the correct seed plates, with a planting rate of 6 seeds per row foot.

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