FLOWABILITY OF BEET SEED AS INFLUENCED BY POLISHING [1]

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The shearing of seed for the purpose of reducing the number of multiple sprout seedballs in planting stock is now a firmly established practice in sugar-beet agriculture. Seed thus produced, however, is extremely variable in shape, and because of this, is difficult to plant in many types of seed drills. To remedy this defect, the use of seed-polishing machinery has been suggested. The purpose of the experiment reported here, was to determine what effect polishing has on drillability of sheared seed, and also what effect standard drills have on polished and unpolished seed.

Materials and Methods

The seed used in this experiment was from American No. 1, produced in Arizona in 1941. This seed was sheared through the standard shear bar type machinery, equipped with an 8-inch diameter 6-inch face stone, and with the shear bar set at .076 inch. The sheared seed was spouted into an air-lift elevator, cleaned, and sized to 7-10/64" through a No. 24-inch Clute separator.

Two hundred pounds of this sheared seed was divided into four 50-pound lots, tested for germination percentage and sprout count and polished* as follows:

1.- No polish (check); 2.- light polish; 3.- medium polish, and 4.- heavy polish.

These four lots were than cleaned over a Clipper mill (model 2-B), and weights obtained on each lot. Each of these seed lots was sized into 9-10, 8-9, 7-8, and 6-7/64th inch fractions, and weights, percentage germination, sprout count, and number of seedballs per pound obtained on each. Twenty-five pound planting samples of each lot were then made up using the same size proportion as that obtained from No. 1, the no polish check lot, for planting purposes.

The seed was then planted through units of two drills, the Planet Jr. and the John Deere No. 10, at speeds of 2, 3, and 4 miles per hour. Plate settings of No. 12 and No. 16 were used

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1/ Contribution of the American Crystal Sugar Company, Rocky Ford, Colorado, to the regional meeting of the American Society of Sugar Beet Technologists, February 1-3, 1944.

2/ Plant Breeder for the Company and Manager of the Rocky Ford Factory, respectively.

* The polisher used was the horizontal type manufactured by the Clute Elevator Company, Rocky Ford, Colorado.

with the Planet Jr. and a 24-cog drill gear and a 72-cell plate with 12/64-inch cell sizes was used with the John Deere No. 10. Three runs of 10 minutes each were used for each planting test, and seed amounts thus obtained were weighed and seeding rates calculated on an acre basis. The seed from each of the three 10-minute runs was then bulked, cleaned, and sized into the four sizes, 9-10, 8-9, 7-8, and 6-7/64th inch over the Clipper mill 2-B with the same setting of air as was used in the preparation of the four seed lots for test. Weight, percentage germination, sprout count and number of seedballs per pound were obtained for each seed size, for each of the planted samples. All germination tests were made in duplicate.

Grease board tests were also made on each of the planters, using the four seed types planted at 2, 3, and 4 miles per hour for both drills. Tests were also made at plate settings of 12 and 16 as additional variables on the Planet Jr. unit. A total of 400 inches (four, 100-inch boards) was obtained for each planting.

Experimental Results

Characteristics of Seed Used -

In table 1 is given changes in size of seedball due to polishing.

Table 1.- Changes in size of seedball due to polishing expressed in percentage.

Seed Treatment	Seed obtained in 1/64" sizes: 9-10	8-9	7-8	6-7	discard	Total	Seedballs per lb. on basis of recovered sample
Unpolished (ck)	5.0	66.4	27.8	.8	0.0	100.0	53,634
Light polish	2.5	60.3	27.9	1.0	8.3	100.0	56,669
Medium polish	1.2	56.0	27.0	1.3	14.5	100.0	56,519
Heavy polish	.6	41.5	26.4	1.4	30.1	100.0	56,027

Comparing the discard percentage (seed and polishings below 6/64") it will be noted that for the polished lots listed as light, medium and heavy, weight percentages of 8.3, 14.5, and 30.1 were lost, respectively. In the 6-7 size increases in proportion were obtained with increases in amount of polishing. The 7-8 size remained similar to the check but in the 8-9 and 9-10 sizes, decreases in amount were obtained with increases in amount of polishing. The number of seedballs per pound obtained for the unpolished check was greater than the light, medium, and heavy polishes by 3,035, 2,885, and 2,393 seedballs per pound, respectively.

In table 2 is given the changes obtained in germination percentage and in sprout count caused by polishing. From this table it is observed that no very great change took place in number of multiple sprout seedballs per 100 germinated. Slight reduction of percentage germination and in number of single sprout seedballs per 100, however, is indicated for increasing amounts of polish.

Table 2.- Changes in germination due to polishing.

Polish	Percentage germination	Count per 100 seedballs		
		Singles	Multiples	Total
None	70.27	51.22	19.04	85.71
Light	70.69	49.85	19.88	92.63
Medium	68.18	47.62	18.85	91.03
Heavy	68.53	47.80	18.36	88.92

Since the germination data shown in table 2 were obtained from duplicate tests of seed of each of the four sizes 9-10, 8-9, 7-8, and 6-7/64th inch for all of the four seed lots, it is interesting to note which size was the most seriously reduced. In the 9-10 size, germination percentage was lowered from 77.0 on the check to 67.0 on the heavy polish. The 8-9 size was reduced from 73.5 to 69.5. In the 7-8 and 6-7 sizes, however, increases in germination were obtained of 10 percent and 8 percent over the check, respectively. Since these were the sizes which were somewhat increased in proportion due to polishing, it would be expected that the average germination of each of the polished samples would not differ greatly from the check.

Comparison of Planting Rates -

The weight of seed planted of the four polished types in the Planet Jr. drill at 2, 3, and 4 miles per hour drill speed, and at plate settings of No. 12 and No. 16, along with the variance table, is shown in table 3.

Table 3.- Comparison of rates of planting using four types of seed in the Planet Jr. drill with three speeds of travel and two planter plate settings.

Seed types	No. 12 set				No. 16 set			
	2 MPH	3 MPH	4 MPH	Ave.	2 MPH	3 MPH	4 MPH	Ave.
No polish	3.20	2.35	1.82	2.46	6.75	5.07	3.91	5.24
Light	3.16	2.31	2.00	2.49	6.75	5.36	4.20	5.10
Medium	3.27	2.56	1.95	2.59	6.94	5.30	4.27	5.50
Heavy	3.28	2.65	9.94	2.62	7.36	5.60	4.44	5.80
Average	3.23	2.47	1.93		6.95	5.33	4.21	

Significant difference (19:1) -- .130

Variance Table

Variation due to:	D/f	Mean Squares	F	Signif. beyond.
Replication	2	.0039	-	ns
Polish types	3	.4213	66.87	1 %
Speeds of travel	2	24.8201	3,939.70	1 %
Planter plate settings	1	157.0878	24,934.57	1 %
Polish types x speeds of travel	6	.0266	4.22	1 %
Polish types x pl. plate settings	3	.1197	19.00	1 %
Speeds of travel x pl. plate settings	2	3.1758	504.10	1 %
Speed of travel x pl. plate settings x polish type	6	.0277	4.40	1 %
Interaction (error)	46	.00630		
Total	71	5.25186		

As would be expected, the greatest source of difference in planting rate was found in the planter plate settings, followed by the speeds of travel, and the interaction between these two main variables. In fourth place for source of difference in planting rate is the seed type. The F value of 66.87 obtained for this variable indicates that it is of relatively minor importance in comparison with the other three variables. Nevertheless, increases of poundage planted per acre are indicated for polished at each of the three speeds and the two plate settings. Significant increases were more frequent with the plate set at No. 16, indicating that the larger sized hole allowed polished seed to flow more freely than from the smaller hole. Observations during the planting tests indicate that the No. 12 hole is the extreme lower limit for use with seed of 7-10/64th inch size.

Planting rates per acre at 2, 3, and 4 miles per hour for the John Deere No. 10 drill are shown in table 4, along with Variance table.

Table 4.- Comparison of rates of planting using four types of seed in the John Deere No. 10 drill equipped with a 24-tooth gear and a 72-cell (12/64-inch) plate at three speeds of travel.

Amounts of polish	2 MPH	3 MPH	4 MPH	Average
None	4.98	4.60	4.41	4.66
Light	5.38	4.82	4.83	5.01
Medium	5.39	4.92	4.92	5.08
Heavy	5.47	5.01	5.04	5.17
Average	5.31	4.84	4.80	
Sign. diff. (19:1) -- .20				

Variance Table

Variation due to:	D/F	Mean Squares	F	Signif. beyond:
Replication	2	.0106	-	ns
Polish type	3	.4465	31.22	1 %
Speed of travel	2	.9457	66.13	1 %
Polish type x speed of travel	6	.0101	-	ns
Error	22	.0143		
Total	35	.1037		

In this test, the analysis of variance indicates that speed of travel was the most important variable in planting rate per acre, with type of polish second. There are two explanations for the lack of average uniform planting rate with this force-feed drill, namely (1) inaccuracy of the drill, (2) lack of filled cells in the 72-hole plate. It is probable that the latter explanation is the more correct, since at slower speeds a significantly greater amount of seed was planted than at higher speeds. The lower speed would allow more cells to be filled with seed than at the higher speeds. Since polished seed gave significantly higher planting rates per acre than unpolished seed in each of the three speeds, it appears that the polished seed filled the cells somewhat more completely than unpolished seed.

Characteristics of Planted Seed Samples in Comparison with Seed Samples Before Planting -

As a result of planting in the Planet Jr., and in the John Deere No. 10 drill, seed of the four types used in this experiment were further changed in size, and in percentage germination and sprout count. This data is given in table 5.

There were no significant differences in percentage loss in weight due to planting in the Planet Jr. drill, the average loss being 2.97 percent of the total weight introduced. Samples planted through the John Deere No. 10 drill, however, showed highly significant differences in percentage loss between the unpolished check and the medium and heavy polish types. It is apparent that polishing measurably reduced seed loss with this drill. It must be noted, however, that damage was excessive for all types of seed planted with the John Deere No. 10 drill.

Breakage of seed due to planting was also observed in the counts of number of seedballs per pound. After taking into account the number of seedballs per pound in each of the four planting samples, the increase in number of seedballs per pound due to planting was obtained in percentage, as shown in table 5. For both drills great increases were observed in the unpolished check, with much lesser increases for the polished samples. For

the John Deere No. 10 drill, increases for all seed types were greatly in excess of those observed for the Planet Jr. This increase in number of seedballs per pound is further evidence of breakage of seed due to planting in this drill.

Table 5.- Changes in size, number of seedballs per pound, percentage germination, single-sprout percentage, due to planting.*

Polish	Percentage loss in weight after planting		Percentage increase in number of seedballs per pound after planting	
	Drill		Drill	
	Planet Jr.	J. Deere	Planet Jr.	J. Deere
None	2.85	7.97	14.52	26.39
Light	2.35	7.68	2.80	11.72
Medium	3.32	6.86	4.27	12.02
Heavy	3.37	5.92	5.36	16.10
Sig. dif.	1.04	1.11	-	-
No. of tests in average	6	3	-	-

Comparison of:

Polish	Germination percentage			Single-sprout percentage		
	Before Plant.	After planting and recleaning		Before Plant.	After planting and recleaning	
		Drill			Drill	
		Planet Jr.	J.Deere		Planet Jr.	J. Deere
None	70.27	69.30	63.44	72.9	74.4	81.3
Light	70.69	71.71	64.27	70.5	73.8	78.0
Medium	68.18	72.53	64.59	69.8	72.4	78.3
Heavy	68.53	71.56	64.77	69.8	70.6	76.0
Sig. dif.		3.26	4.84	-	4.7	7.4
No. of tests in average		48	24	-	48	24

* Sizes of 6/64 inch and below were considered as loss.

Of the four planted samples, very little change took place in the Planet Jr. planting for germination percentage. In the John Deere plantings, however, a serious reduction was obtained for all four types of seed. No reliable differences between seed types was obtained for either of the planters. In percentage of single-sprout seedballs (based on germinating percentage of samples) no reliable differences were obtained between any of the four seed types for the Planet Jr. planting. As an average, however, single sprouts appear to have increased slightly over that obtained in the planting sample. In the John Deere plantings, a much higher percentage of single sprouts was found, in comparison to that obtained in the planting samples. This again emphasizes the breakage of seed which occurred in this drill. Although differences are not significant for the four seed types, a larger number of single sprouts in the unpolished check as compared with the heavy polish sample could be expected, considering the damage observed from the loss in weight, and the increase in seedballs per pound obtained for these same types.

Comparisons of Number of Viable Seed Planted per Acre -

Since it is important to know the amount of viable seed which was being planted per acre with each of the four seed types, this was calculated for each drill and is given in table 6.

Table 6.- Comparison of number of viable seed planted using the Planet Jr. drill and the John Deere No. 10 drill, with four seed types.

Polish	Planet Jr.			John Deere No. 10		
	Pounds planted	No. viable seed planted		Pounds planted	No. viable seed planted	
		Per acre	Per row foot*		Per acre	Per row foot*
None	3.85	159,208	6.09	4.66	184,444	7.06
Light	3.96	161,097	6.16	5.01	187,659	7.18
Medium	4.05	163,027	6.24	5.08	189,665	7.26
Heavy	4.21	164,896	6.31	5.18	196,672	7.52

* space between rows, 20 inches

In arriving at these results, the pounds planted per acre were multiplied by the amount recovered in the 6-10/64th size after planting. This poundage of actual seed planted per acre was then multiplied by the recovered number of seedballs per pound, which in turn was multiplied by the recovered germination percentage, to give viable seedballs planted per acre.

From this table it is evident that polishing of seed increases the rate of viable seed planted per acre. With both drills, gradual increases in seeding rate were evident between each of the four seed types.

Tests of Seed Dispersion

Grease-board tests were run on the Planet Jr. and John Deere No. 10 drills at 2, 3, and 4 miles per hour to determine the relative effect of polishing on seed dispersion. Plate settings of No. 12 and No. 16 were used for the Planet Jr. and the standard 24-cog gear and the 72-cell plate for the John Deere. Counts of skips in inches, and inches with single or more seeds are given in table 7.

Table 7.- Tests of dispersion of seed* of four types planted through Planet Jr. and John Deere No. 10 drills.

Inch category		Planet Jr. polish types				John Deere No. 10 polish types			
		1	2	3	4**	1	2	3	4**
Skips of:	8"	1							
	7"		1						
	6"	1	1	2	1	3	1	2	
	5"	6	3	4		5	2	3	3
	4"	13	8	6	7	6	10	9	4
	3"	23	22	20	16	30	22	28	24
	2"	46	48	42	44	85	72	67	63
	1"	90	97	120	115	172	182	184	193
Seeds per inch:									
	1	269	300	279	298	452	462	471	499
	2	134	122	148	138	196	189	206	210
	3	42	50	42	64	39	73	67	52
	4	8	9	10	11	11	11	11	14
	5			1	3	2	2		3
					1				
Seed counted		695	730	746	831	1020	1113	1128	1146
No. of inches		800	800	800	800	1200	1200	1200	1200

* Planet Jr.: No. 16 plate hole, 3 and 4 miles per hour. John Deere No. 10: 24 gear, 72 cell (12/64") plate, 2, 3, and 4 miles per hour.

** Polish types 1 to 4 are check, and light, medium and heavy polishes, respectively.

Since the No. 12 plate hole on the Planet Jr. was found to restrict the free flow of the sheared seed samples of the size used in this experiment, and since this drill is more of a gravity flow type than a force feed, it was decided to use only the No. 16 plate hole at 3 and 4 mile per hour speeds, for the dispersion comparisons between the four types of seed. The John Deere tests are an average of the 2, 3, and 4 miles per hour speeds for each seed type.

Comparisons of seed dispersion from this table are complicated by the fact that there is an increase in the rate of

planting due to polishing of seed (table 6). For each drill, observation of the total inches containing one seed along with the 1-inch skips indicate that an increasing number of these desirable placements were obtained with increasing amounts of polish. However, it is noted that with increasing amounts of polish, more clusters of 2, 3, 4, and 5 seeds per inch are found, and correspondingly less 3 to 8-inch skips. Therefore, it appears that dispersion of seed in the row was influenced very little by seed polish in this experiment.

Summary

When sheared seed is polished there is a loss in weight. For the three grades of polish used in this experiment, light, medium, and heavy, losses of 8.3 percent, 14.5 percent, and 30.1 percent were obtained. Most of this loss was corky material however, since no reduction in germination percentage was obtained on the light polished sample, and only slight reductions on the medium and heavy polishes. Polished seed, as compared with the unpolished check, was characterized by (1) a smaller average size seedball, (2) a larger number of seedballs per pound.

In the planting experiments, it was observed that plate setting (Planet Jr.) and speed of travel of the planter unit had a relatively greater effect on planting rate than the polishing of seed. With both the Planet Jr. and the John Deere No. 10 drills, greater amounts of viable seed were planted per acre, with increasing amounts of polish. Loss of weight of seed when planted in the Planet Jr. averaged 2.97 percent with no significant differences between polish types. For the John Deere, loss of seed weight averaged 7.11 percent, with the heavy polish significantly lower than the unpolished check. Number of seedballs per pound averaged 6.74 percent higher for samples planted in the Planet Jr. and 15.88 percent* for the John Deere No. 10 drill. The increase was much less for polished samples from both drills, indicating that there was less breakage of polished seed in the planting operation.

Germination tests showed no significant differences between polish types for either germination percentage or percentage of single-sprout seedballs, for either of the two drills. In comparing percentage germination and percentage single-sprouts in samples before and after planting, a very slight increase was noted for the seed planted with the Planet Jr. In the case of the John Deere, an average reduction of 5.15 percent in germination percentage was obtained. Proportionate increases in percentage of single-sprout seedballs was also observed, this being somewhat higher for the unpolished sample. This again points to the severe action of the John Deere No. 10 drill on sheared seed.

Tests of seed dispersion made with each drill on the four seed types indicated no appreciable difference in placement for these types of seed.

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* higher

Conclusions

The results obtained indicate that polishing reduced the amount of seed damage incurred in planting. Light polishing (8.3 percent loss in weight) appeared to be the maximum required to produce the best sample for planting in the Planet Jr. drill. Although polishing reduced damage in samples planted in the John Deere No. 10 drill, the severe action of this drill greatly reduces the small beneficial effect obtained from the polishing.

A light polish does produce an excellent appearing seed sample, and one which is likely to arrive at the drill in the field in better condition than unpolished seed. However, until drills are adapted which will plant normal sheared seed in a more satisfactory manner it must be concluded that no very great benefit can be expected from the polishing of sheared beet seed.