

Emergence and Rate of Emergence of Sugar Beet Seed as Influenced by Seed Preparation, Soil Moisture and Temperature

L. D. LEACH, ROY BAINER, and L. D. DONEEN¹

Processing of sugar beet seed to aid precision planting and to reduce the labor involved in thinning operations constitutes an important phase in the mechanization of sugar beet culture.

Among the methods of seed processing now in use or under experimentation are segmentation, decortication and pelleting. Segmented seed, prepared by methods developed by Bainer (1) (2) ², is widely used in commercial plantings. Its chief advantage is in the reduced number of seedlings per viable seed unit and the consequent production of a high percentage of single seedlings. Decorticated seed prepared by the mechanical removal of the cork from beet seed balls was also developed by Bainer (3). Seed units prepared in this manner are characterized by uniform size, smooth surface, high density, and high germination. They lend themselves exceptionally well to precision planting but they do not have the degree of singleness shown by segmented seed. Only limited experimental plantings with decorticated seed have been made so far. Pelleting of segmented seed has been described by Reeve (7). The final product, because of its uniformity and high density, lends itself to precision planting and the degree of singleness can be controlled by the seed selected for pelleting. Fungicides and fertilizers are also incorporated in some types of pellets.

The present studies were undertaken to determine whether the processing of seeds affects their ability to germinate and emerge at different levels of soil moisture and at high and low temperatures. In addition to the number of seedlings produced, we have considered the rate of emergence, since under fluctuating field conditions small differences in the time required for emergence may determine the success or failure of a planting.

Methods

The segmented and decorticated seeds were prepared by Bainer from the same lot of whole seed (variety U.S. 33, lot 343), samples of which were used for the control. The pelleted seeds were prepared and furnished by the Farmers and Manufacturers Beet Sugar Asso-

¹Associate Plant Pathologist, Agricultural Engineer, and Associate Irrigation Agronomist, respectively. California Agricultural Experiment Station, Davis, Calif.

²Italic numbers in parentheses refer to literature cited.

ciation, and unpelleted seed from the same lot was used for the control. Samples for each planting were selected mechanically by passing the entire seed lot repeatedly through a Boerner sampler.

All plantings were, made in Yolo fine sandy loam soil and at moisture percentages in or close to the range of "readily available moisture", as described by MacGillivray and Doneen (6). This range extends from the field capacity, which is the moisture held in a soil when movement has practically ceased after a rain or irrigation, to the permanent wilting percentage (P.W.P.) or the soil-moisture content at which plants wilt and do not recover unless water is added to the soil. When the field capacity is determined in the laboratory, it is known as the moisture equivalent (M.E.). The moisture equivalent for this soil is 15.8 percent and the permanent wilting percentage is 8.8 percent based on the dry weight of soil.

All soil was pasteurized before planting by passing it twice through a soil pasteurizer of the type described by Tavernetti (8). The soil was then screened through a 2-mm. screen and the moisture was adjusted by Doneen, using the method described by Doneen and MacGillivray (4).

All seeds were planted in friction top cans, each containing 300 grams of soil below and 100 grams of soil above the seeds. Ten whole or decorticated seeds and 15 segmented or pelleted seeds were planted in each can, the difference in numbers compensating for the differences in the number of seedlings per viable seed unit for the seed types.

Each seed type was planted in 10 cans of soil at each soil moisture (8.2, 9.0, 10.2, 13.0, and 16.3 percent) and duplicate plantings were made at temperatures of 50° F. (10° C.) and 70° F. (21° C.). The mean variation in each chamber was less than $\pm 1^\circ$ F. during the trials. To measure the rate of emergence, seedlings in each can were counted daily during the emergence period. Each daily increase in emergence was multiplied by the number of days since planting and the sum of the products divided by the total emergence to give the mean emergence period in days as proposed by Leach and Smith (J).

Laboratory tests showed the following germination percentages and seedlings per 100 seed units: Whole seed—83 percent and 151 seedlings; decorticated seed—83 percent and 131 seedlings; segmented seed—78 percent and 95 seedlings. Greenhouse tests in pasteurized soil yielded comparable germinations for each seed type.

Experimental Results with Whole, Decorticated, and Segmented Seed

Tests in controlled soil moistures at 70° F. (table 1) showed that all three seed preparations germinated at 9.0 percent and above but

Table 1.—Effect of seed preparation and soil moisture on emergence at 70° F.

Seed preparation	Soil moisture—percent				
	8.2	9.0	10.2	13.0	16.3
	Seedlings per 100 seed units				
Whole	0	113.0	144.0	153.0	162.0
Decorticated	0	112.0	139.0	151.0	137.0
Segmented	0	73.0	91.0	95.0	91.0
	Percent of potential emergence				
Whole	0	75.2	95.5	101.5	107.5
Decorticated	0	85.4	105.8	115.0	104.4
Segmented	0	77.2	95.8	99.7	95.8
	Mean emergence—days				
Whole		9.40	6.58	5.50	5.19
Decorticated		8.05	5.60	4.77	4.80
Segmented		8.32	5.62	4.96	4.66

Permanent wilting percentage—8.5; moisture equivalent—15.8 percent.

not at 8.2 percent, just below the permanent wilting percentage. Reference to the second portion of table 1 shows that a higher percentage of the potential emergence was obtained from decorticated than from whole or segmented seed at lower moisture but not at 16.3 percent, which is above the moisture equivalent.

According to table 1, both decorticated and segmented seed germinated more rapidly than whole seed at all soil moistures, as indicated by the mean emergence period. The emergence curves, in figure 1A, show striking differences at 9 percent soil moisture, whereas at 13 percent (figure 1B) smaller differences occurred.

At 50° F. (table 2) a longer emergence period was required and differences in emergence rates are more obvious than at 70° F. Decorticated seed again produced a higher percentage of potential emergence at 9 and 10 percent than whole or segmented seed, but this relation was apparently reversed at 16.3 percent.

Table 2.—Effect of seed preparation and soil moisture on emergence at 50° F.

Seed preparation	Soil moisture—percent				
	8.2	9.0	10.2	13.0	16.3
	Seedlings per 100 seed units				
Whole	0	137.0	144.0	140.0	152.0
Decorticated	3	127.0	142.0	124.0	118.0
Segmented	0	51.0	87.0	93.0	93.0
	Percent of potential emergence				
Whole	0	91.0	95.6	93.0	100.8
Decorticated	2.3	96.5	108.2	93.0	89.2
Segmented	0	85.2	91.6	97.9	97.9
	Mean emergence period—days				
Whole		24.37	17.39	14.98	14.76
Decorticated		20.66	16.45	14.47	14.66
Segmented		23.72	17.02	14.79	14.55

Permanent wilting percentage—8.8; moisture equivalent—15.8 percent.

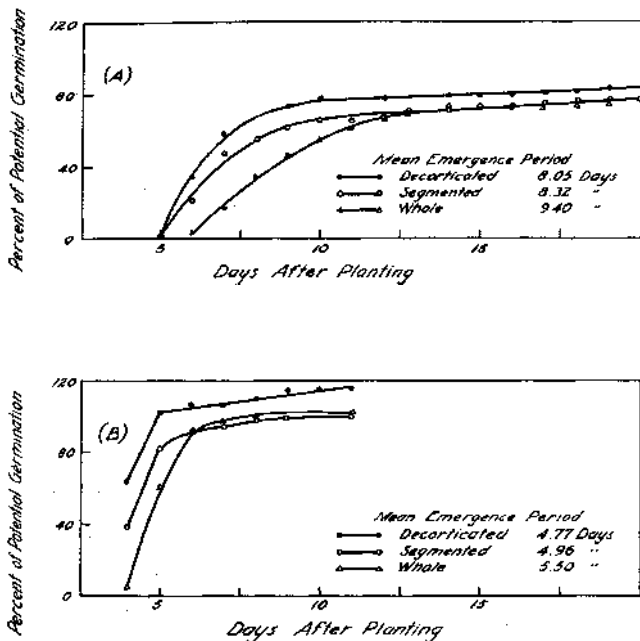


Figure 1.—Effect, of preparation of sugar beet seed on emergence of seedlings at 70° F. A: At 9 percent soil moisture decorticated seed showed a mean emergence period 1.35 days less than whole seed while segmented seed was intermediate in emergence rate; B: At 13 percent soil moisture each seed type showed only about half as long an emergence period as at 9 percent but the order of emergence was the same.

The emergence period for decorticated seed at 9 percent soil moisture was considerably shorter than that for whole or segmented seed, but as the moisture increased, the differences in rate of emergence decreased. Figures 2A and B show the effect of seed processing on the time required for emergence in 9 and 13 percent soil moisture at 50° F. By the twentieth day after planting, when emergence of decorticated seed in 9 percent soil moisture was 56 percent completed, whole seed showed only 14 percent and segmented seed 20 percent of their potential emergence. Such a difference would be extremely important if conditions during germination became sufficiently unfavorable to prevent late emergence.

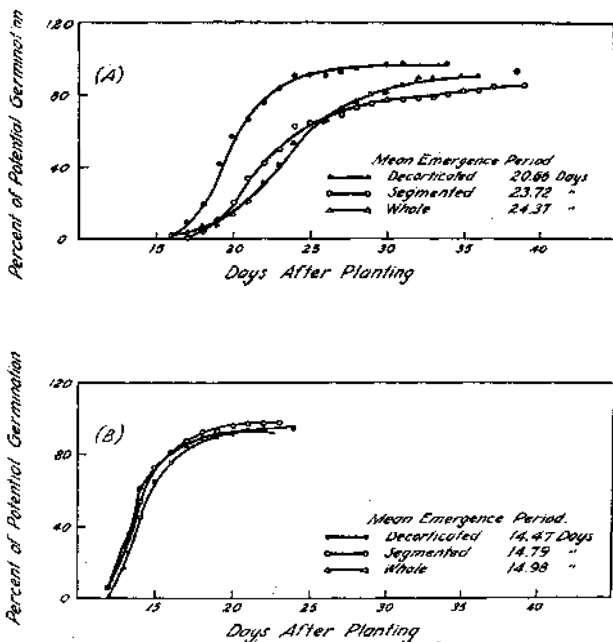


Figure 2.—Effect of preparation of sugar beet seed on emergence of seedlings at 50° F. A: At 9 percent soil moisture, decorticated seed showed a mean emergence period 8.7 days shorter than whole seed B. At 13 percent soil moisture, however, there was less than a day difference in the mean emergence periods of whole, segmented, or decorticated seeds.

The effect of soil moisture upon the mean emergence period for whole, segmented, and decorticated seeds at both high and low temperatures is shown in figure 3. As indicated previously, the greatest differences occur at low soil moistures and at a low temperature.

Separate tests conducted in greenhouse soil have shown that with seed of comparable quality, whole sugar beet seed germinates more slowly than either segmented or decorticated seed and that emergence from decorticated seed is the most rapid. It is believed that the removal of the outer portions of the beet seed ball during processing increases the rate of moisture absorption and thus hastens germina-

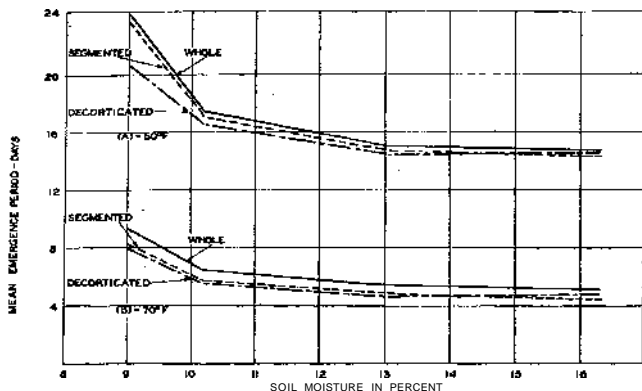


Figure 3—Effect of soil moisture on the time required for emergence of whole, segmented, and decorticated sugar beet seed at (A) 50° F. and (B) at 70° F. It required three times as long for seedlings to emerge at 50° as at 70° F. Practically no emergence occurred below the permanent wilting percentage—S.N. Emergence rates at soil moistures between 10 percent and above the moisture equivalent, 15.8 percent, differed only slightly, but at 9 percent emergence was delayed by several days. Decorticated seed germinated considerably faster than segmented or whole seed at 9 percent soil moisture, but at higher soil moistures the differences between seed types were less pronounced.

tion. This opinion is supported by the fact, illustrated in tables 1 and 2, that the differences in time required for emergence are greater at low than at high soil moistures. Lowering the temperature from 70° to 50° F. more than doubled the time required for emergence and the differences in emergence rates were similarly affected.

Experimental Results with Segmented and Pelleted Segmented Seed

To determine how pelleting of segmented sugar beet seed affected the emergence and rate of emergence at different soil moistures and at high and low temperatures, a similar series of trials was conducted using seed prepared and furnished by the Farmers and Manufacturers Beet Sugar Association.

Preliminary to the controlled experiments two greenhouse plantings were made in pasteurized soil, one on April 6, 1945, a few days after the seeds were received, and the other on October 26, 1945, after the seeds and pellets had been stored for 6 months in a dry laboratory.

The results in table 3 show that the emergence from both white and blue pellets was somewhat lower than from the unpelleted seed and that the pellets required a longer emergence period.

Table 5.—Effect of pelleting segmented sugar beet seed upon emergence and rate of emergence, greenhouse plantings in sterile soil.

Seed preparation	Moisture; addition during germination	Trial of April 6, 1945 ¹		Trial of Oct. 26, 1945 ²	
		Emergence per 100 seed units	Mean emergence period—days	Emergence per 100 seed units	Mean emergence period—days
Segmented—unpelleted	watered	88	8.95	75	0.47
Segmented—unpelleted	not watered			02	7.51
Segmented—white pellets	watered	5	10.41	50	8.22
Segmented—white pellets	not watered			35	10.96
Segmented—blue pellets	watered	59	11.55	23	10.04
Segmented—blue pellets	not watered			30	16.16
Significant difference 9:1 odds		14.7	0.86	13.4	1.86

¹Temperature range—43° to 81° F.; mean—61° F.

²Temperature range—52° to 83° F.; mean—64° F.

³Not tested.

After 6 months storage the white pellets showed the same relation to the unpelleted seed as in the original trial, but the blue pellets were noticeably lower in germination and slower to emerge. The deterioration of the blue pellets was probably due to the incorporation of organic mercury fungicides in the pellets and was predicted by the manufacturer.

Withholding water until the seedlings started to emerge delayed the germination of all lots, but the effect was more pronounced upon the pelleted seeds.

In the trials conducted in constant soil moistures at both 70° P. and 50° P. (tables 4 and 5) unpelleted seeds again produced more seedlings per 100 seed units than either white or blue pellets. As soil moistures were lowered, differences in emergence increased. The poor performance of the blue pellets, however, is probably due to chemical injury during storage, as indicated above.

Table 4.—Effect of pelleting on emergence and rate of emergence of segmented seed at 70° F.

Seed preparation	Soil moisture—percent				
	8.1	9.2	10.3	13.1	16.8
	Seedlings per 100 seed units				
Segmented—unpelleted	0	67	81	70	77
Segmented—white pellets	0	26	50	68	61
Segmented—blue pellets	0	5	23	45	27
	Mean emergence period—days				
Segmented—unpelleted	...	7.89	6.60	5.14	5.06
Segmented—white pellets	...	10.50	8.24	6.51	7.00
Segmented—blue pellets	...	13.25	14.85	12.42	14.70

Permanent wilting percentage—8.8; moisture equivalent—15.8 percent.

Table 5.—Effect of pelleting on emergence and rate of emergence of segmented seed at 50° F.

Seed preparation	8.1	Soil moisture—percent			
		9.2	10.3	13.1	16.3
		Seedlings per 100 seed units			
Segmented—unpelleted	0	74	80	78	77
Segmented—white pellets	0	47	55	60	63
Segmented—blue pellets	0	14	38	42	28
		Mean emergence period—days			
Segmented—unpelleted	...	21.28	19.21	15.08	15.51
Segmented—white pellets	...	28.83	24.83	19.59	19.40
Segmented—blue pellets	...	35.68	29.38	25.08	29.07

Permanent wilting percentage—8.8, moisture equivalent—15.8 percent.

The time required for emergence of the white pellets was greater than for unpelleted seeds, and the differences increased at the lower-soil moistures. Emergence curves at .13 percent soil moisture are shown in figure 4.

These results can be interpreted only as applying to the particular seed lots furnished for these tests and may not be typical of the performance of other lots or preparations. They do indicate, however, that with this seed lot the coating applied to the seed increased the difficulty of germination. With the white pellets, emergence at both 50° and 70° P. was improved by an ample supply of soil moisture.

Summary

To determine whether the processing of sugar beet seeds affected their ability to germinate, samples of whole, decorticated, segmented, and pelleted seeds were tested in a series of soil moistures and at high and low temperatures.

All plantings were made in cans containing pasteurized soil adjusted to certain moisture levels ranging from near the permanent wilting percentage to near the field capacity. Duplicate plantings were made at 50° F. (10° C.) and at 70° F. (21° C.).

It was found that decorticated sugar beet seed germinated faster and showed a higher percentage of potential emergence than whole seed at low soil moistures. Segmented seed in most cases was intermediate between whole and decorticated seed. At high soil moistures there were only slight differences in rates of emergence between whole, decorticated, and segmented beet seed.

Pelleted beet seeds tested in the same manner showed a lower emergence and a longer emergence period than unpelleted seed from the same source. In low soil moistures the delay in emergence from pelleted seeds was more pronounced.

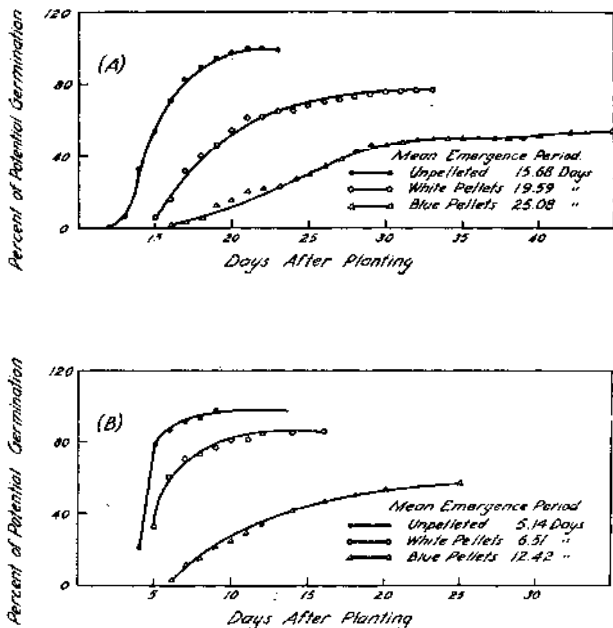


Figure 4.—Comparison of the emergence rates of segmented and pelleted sugar beet seed at 1-1.1 percent soil moisture and at (A) 50° K. and (H) 70° F. The white pelleted seed which contained cuprous oxide and chloronil germinated somewhat more slowly than the unpelleted seed, and the delayed emergence was more pronounced at the lower temperature. The extreme delay of emergence shown by the blue pellets, which contained an organic mercury fungicide, was due in part to chemical injury during (3 months) storage and would not be typical for a fresh preparation.

At 50° F. the emergence periods for all seed lots were more than twice as long as at 70° F., and the difference between emergence rates for the various seed preparations were correspondingly increased.

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